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Research Article

COMPARING THE PARAMETERS EXTRACTED USING LAMBERT FUNCTION AND GENETIC ALGORITHM BASED ON ORGANIC SOLAR PANELS

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ABSTRACT
The parameters in the design of solar panels, using the Lambert function and genetic algorithm were studied. With this function by using the experimental results, the impact of temperature was checked and found that an increase in temperature also reduces the open circuit voltage and current of the first diode reverse saturation as well as the increased interest of congestion. Short circuit current, the carriers recombine, the mobility of carriers, photo-diode currents flow in the cell and the second solar cells. Lambert function can be extracted using a genetic algorithm optimization of data.

Keywords: *Lambert Function, Algorithm Genetics, Organic Solar Panel*

INTRODUCTION
Due to the benefits such as production cost, low costs of electric energy generation, and the ability to use flexible layers, organic solar cells, compared to inorganic solar cells, are good alternative conjugated polymers for inorganic semiconductors. This is the reason why solar cells have drawn a lot of attention in recent years (Chang and Wang, 2008). However, with regard to many efforts for increasing the efficiency of power conversion, this parameter is still less than the silicon solar cells (Katza *et al.,* 2001). The temperature effect is of effective factors on the efficiency of solar cells. There are different models to theoretically review the photovoltaic cells. In this work, the two-diode model was used to define the structure of solar cells (Bonkoungou *et al.,* 2004).

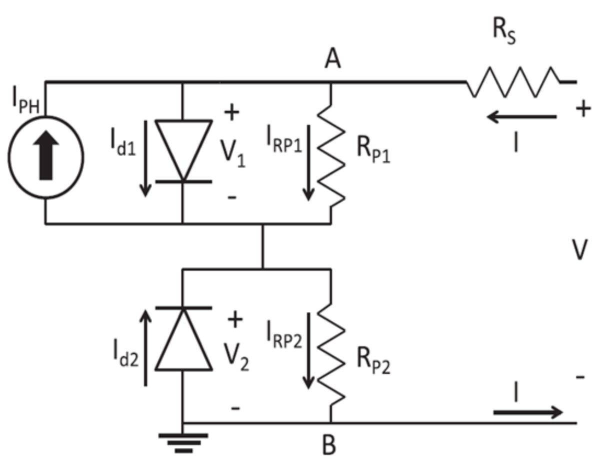

Figure 1: The equivalent circuit of solar cells irradiated based on two-diode model

Knowing about the parameters of solar cells such as the reverse saturation current of the diodes, parallel resistors, the ideal factor, and the photocurrent give us important information on their quality control performance determination. There are different ways to determine the parameters of solar cells including five-parameter method (Bonkoungou *et al.,* 2007), a new method based on optimization (Chegaara *et al.,* 2004), using compatible and improved development (Gong and Caia, 2013), genetic algorithm (Amani *et* *al.*, 2001), parameter extraction using Lambert method (Romero *et al.*, 2012) and so on. In this work, using the Lambert method we investigated the success of finding solar cell parameters and were able to find information about that, such as the reverse saturation current of the first and second diode, the first and second parallel resistance, the ideal factor and the first and second diode as well as the photocurrent.

Model

Several models have been introduced to determine the current-voltage behavior of solar cells. One of these models is two-diode equivalent-circuit model which has modeled the wastes in the est way (Figure 1). As seen, the electric equivalent circuit, including diode $d_2$and a parallel resistantR_{p2}, has been located in a parallel form with the standard one-diode circuit which includes a current source, and series R_S and parallel resistants R_{sh} .

$I_{RP2}, I_{RP1} R_s, R_{p2}, R_{p1}, I_{d2}, I_{d1}, I_{PH}$are photocurrent, current passed through the first diode, current passed through the second diode, the first parallel resistant, the second parallel resistant, current passed through the first parallel resistant, and current passed through the first parallel resistant (Romero *et al.*, 2012).

Using Kirchhoff's circuit laws, the relation between current and voltage in nodes A and B of this circuit can be written as equations (2) and (3):

$$V = IR_s + V_1 + V_2 \quad (1)$$

$$I = I_{01}\left[pex\left(\frac{V_1}{n_1KT}\right) - 1\right] + \frac{V_1}{R_{p1}} - I_{ph} \quad (2)$$

$$I = I_{01}exp\left(\frac{V_1}{n_1KT}\right) - I_{01} + \frac{V_1}{R_{p1}} - I_{ph} \quad (3)$$

In order to replace in the relation (1) we use expressions (3) to order voltages V1 and V2 in terms of Lambert function (Corless *et al.*, 1996), Therefore we have the following relations:

$$V_1 = \left(I + I_{ph} + I_{01}\right)R_{p1} - n_1KTW\left[\frac{I_{01}}{n_1KT}exp\left(\frac{\left(I + I_{ph} + I_{01}\right)R_{p1}}{n_1KT}\right)\right] \quad (5)$$

$$V_2 = n_2KTWI_{02}R_{p2}exp\frac{-(I - I_{02})R_{p2}}{n_2KT} + -(I - I_{02})R_{p2} \quad (6)$$

Now we put these two relations in equation (1).

$$V = \left(I + I_{ph} + I_{01}\right)R_{p1} - n_1KTW\left[\frac{I_{01}}{n_1KT}exp\left(\frac{\left(I + I_{ph} + I_{01}\right)R_{p1}}{n_1KT}\right)\right] + n_2KTWI_{02}R_{p2}exp\frac{-(I - I_{02})R_{p2}}{n_2KT} \quad (7)$$

Extracting the Parameters

The way of extracting parameters is that we use Digitizer software to separate the voltage-current data from the experimental curve (Romero *et al.*, 2012), (Figure 2) and enter the data in a program we wrote in MATLAB. Then, we extract the effective parameters in designing ($I_{RP2}, R_s, R_{p2}, R_{p1}, I_{d2}, I_{d1}, I_{PH}$) solar cells.

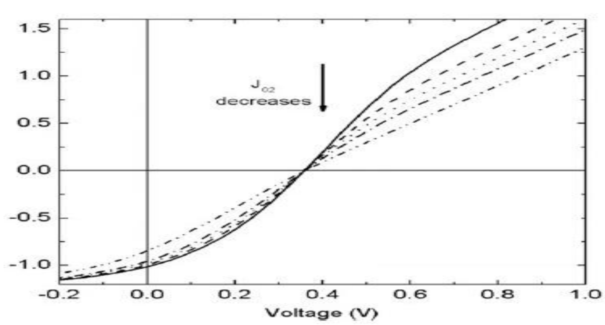

Figure 2: Voltage-current density curve

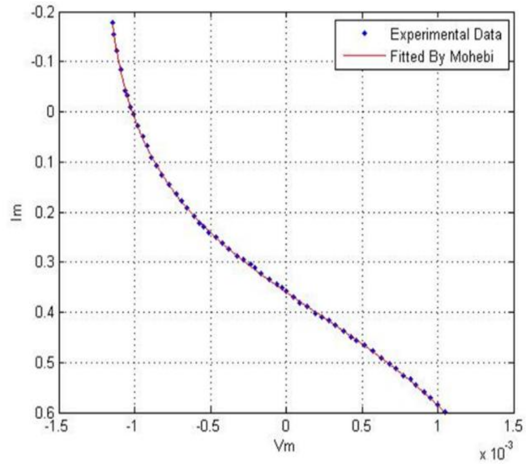

Figure 3: Extracted curve by software using Lambert method

Table 1: Shows the experimental extracted values from the article and the calculated data by MATLAB.

Table 1: Comparison of calculated parameters by the software and article for solar cell

n_2	n_1	R_{p2}	R_{p1}	J_{02} mA/cm2	J_{01} mA/cm2	I_{ph} mA/cm2	
3	6.5	1.6 $K\Omega$	0.7 $M\Omega$	0.86	0.14	1.1	Article data
2.27	6.35	0.34 $K\Omega.cm^2$	0.012 $M\Omega.cm^2$	0.75	0.13	1.07	software data

Comparing the Lambert Function and the Genetic Algorithm

Using Digitizer software, we extract the voltage-flow data from the experimental curve (Romero *et al.*, 2012), introduced by Del Poso *et al.*, (2002) in order to extract the effective parameters in designing solar cells. Then, we enter the data in the program we wrote in MATLAB and extract the effective parameters in designing solar cells. Then we draw the curve (Figure 3) and then compare the achieved parameters with the experimental parameters and the parameters extracted from the genetic algorithm. The following table shows the experimental values extracted from the article and the data calculated by MATLAB.

Table 2: Comparison of the calculated parameters for organic solar cells

n_2	n_1	R_{p2}	R_{p1}	J_{02} mA/cm2	J_{01} mA/cm2	I_{ph} mA/cm2	
3	6.5	1.6 $K\Omega$	0.7 $M\Omega$	0.86	0.14	1.1	Paper data
2.27	6.35	0.34 $K\Omega.cm^2$	0.012 $M\Omega.cm^2$	0.75	0.13	1.07	Data obtained by Lambert program
2	6.42	1.7 $K\Omega$	0.5 $M\Omega$	0.80	0.16	1.2	Data obtained by the genetic algorithm

In the genetic algorithm, we can optimize the obtained parameters. But it requires the effective parameters of solar cells and the results show that the error risk of this method is low due to having the parameters. Therefore, it can be noted that in the genetic algorithm, we must have all the data of a solar cell to make them more optimized. But in the Lambert function method, which is a simple but accurate method, we can extract the effective parameters of solar cells merely by using the experimental curves I and V.

Conclusion

The advantage of this method over the other ones is that we have extracted the effective date of solar cells without having any parameters. Also, regarding the results obtained from the Lambert method shown in Table 2, the losses of the cell with regard to the results of the paper have been decreased. Therefore, considering what mentioned before, using the Lambert method can extract the effective parameters of a solar cell. In out genetic algorithm, we have to have all the date of a solar cell to be able to optimize it. But, in the Lambert function method, which is a simple but accurate method, we can only use the experimental curves I and V to extract the effective parameters of solar cells.

REFERENCES

Amani F, Hajiloo A and Tohidi N (2012). Using neural network and genetic algorithm for modeling and multi-objective optimal heat exchange through a tube bank. *IJE Transactions C: Aspects* **25**(4) 321-326.

Bonkoungou D, Koalaga Z and Njomo D (2013). Modelling and Simulation of photovoltaic module considering single-diode equivalent circuit model in MATLAB. *International Journal of Emerging Technology and Advanced Engineering* **3** 493-502.

Chang YM and Wang L (2008). Efficient poly 3 hexylthiophene based bulk heterojunction solar cells fabricated by an annealing free approach. *Journal of Physical Chemistry C* **112** 17716-17720.

Chegaara M, Ouennoughia Z and Guec F (2004). Extracting dc Parameters of Solar Cells under Illumination. *Vacuum* **75** 367–372.

Cheknane A, Aernouts T and Boudia M (2007). Modelling and Simulation of organic bulk heterojunction solar cells. *Revue des Energies Renouvelables* 83–90.

Corless M, Gonnet GH, Hare DEG, Jeffrey DJ and Knuth DE (1996). On the Lambert W Function. *Advances in Computational Mathematics* **5** 329-359.

Gong W and Caia Z (2013). *Parameter Extraction of Solar Cell Models using Repaired Adaptive Differential Evolution.* Preprint submitted to Elsevier 1-16.

Jervase J, Bourdoucen H and Lawati A (2001). Solar cell parameter extraction using genetic algorithms. *Measurement Science and Technology* **12** 1922–1925.

Katza EA, Faimana D, Cohen Y, Padinger F, Brabec C and Sariciftci NS (2001). Temperature and irradiance effect on the photovoltaic parameters of a fullerene/conjugated-polymer solar cell. *SPIE Proceedings, Organic Photovoltaics* **4108** 117-250.

Ourahmoune O and Belkaid MS (2011). Influence of the blend concentration of P3HT: PCBM in the performances of BHJ solar cells. *Satreset* **1** 90-92.

Ralf Mauer, Ian A Howard and Fr_ed_ericLaquai (2010). Effect of Nongeminate Recombination on Fill Factor in Polythiophene/Methanofullerene Organic Solar Cells. *Journal of Physical Chemistry Letters* 3500-3505.

Romero B, del Pozo G and Arredondo B (2012). Exact analytical solution of a two diode circuit model for organic solar cells showing S-shape using Lambert W-functions. *Solar Energy* **86** 3026–3029.