Efficiency of solar cell

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Abstract - *Energy which comes from natural resources such as sunlight, wind, rain, geothermal heat etc. is called renewable energy. Renewable energy is very important because the non-renewable energy such as petrol, diesel, and fossil fuels are limited. Solar energy is the most easily available source of energy. Most important it is non-conventional source of energy because it is non-polluting, clean etc. The influences of temperature and irradiance variations on the different solar cell parameters are studied. It is useful to understand the effect of temperature and irradiance on the solar cell and module performance, in order to estimate their performance under various conditions. The efficiency of solar module is directly related with the solar parameter and therefore solar parameter changes and affects the efficiency of solar module.*

Keyword:
Solar cell,efficiency.MPPT

I. Intorduction

Solar cells have seen remarkable improvements since the first issue of the journal Solar Energy Materials in 1979.The photovoltaic (PV) field has given rise to a global industry capable of producing many gigawatts (GW) of additional installed capacity per year [1]. The problems with energy supply and use are related not only to global warming but also to such environmental concerns as air pollution, acid precipitation, ozone depletion, forest destruction, and radioactive substance emissions. To prevent these effects, some potential solutions have evolved including energy conservation through improved energy efficiency, a reduction in fossil fuel use and an increase in environmentally friendly energy supplies. Among them, the power generation with solar cells system has received great attention in research because it appears to be one of the possible solutions to the environmental problem [2].

Solar Energy is energy that comes from the sun. The energy uses by solar cells that convert sunlight into direct current electricity. Solar cells are composed of various semi conducting materials. Semiconductors are materials, which become electrically conductive when supplied with light or heat, but which operate as insulators at low temperatures. When photons of light fall on the cell, they transfer their energy to the charge carriers. The electric field across the junction separates photo-generated positive charge carriers (holes) from their negative counterpart (electrons). In this way an electrical current is extracted once the circuitis closed on an external load. Several factors affect solar cell efficiency. This paper examines the factors that affecting efficiency of solar cells according to scientific literature. These factors are changing of cell temperature, using the MPPT with solar cell and energy conversion efficiency for solar cell.

Ii. Solar Cell Circuit

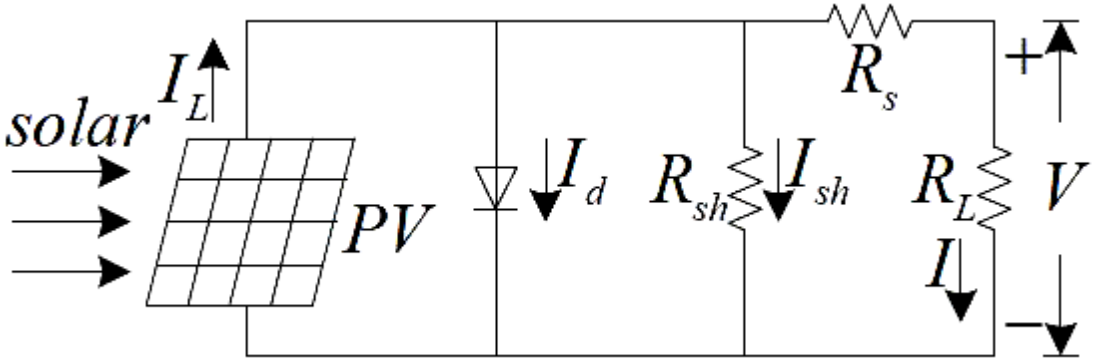

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FIG. 1.1 The equivalent circuit of the solar cell

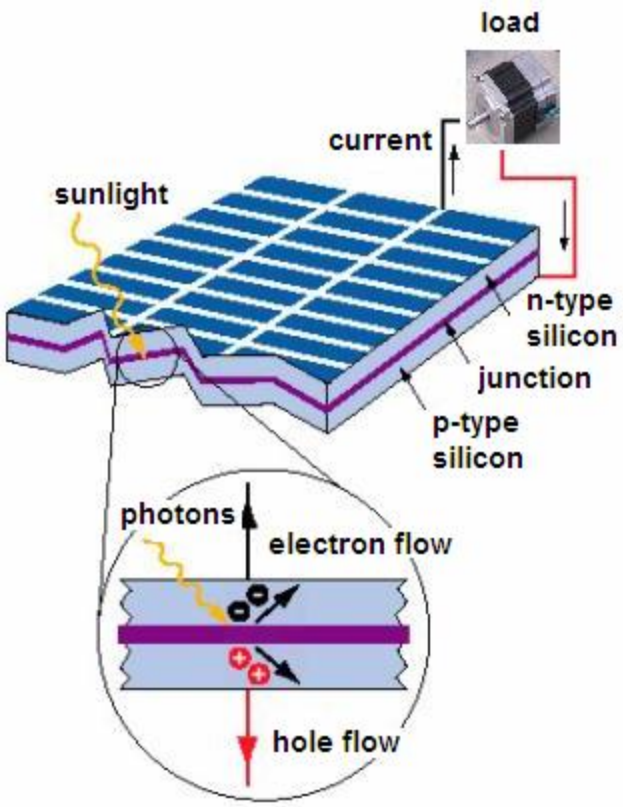

FIG 1.2 A schematic of the layers of a typical PV cell

III. Solar Cells Efficiency Factors

3.1 Cell Temperature:

As temperature increases, the band gap of the intrinsic semiconductor shrinks, and the open circuit voltage (*OC V*) decreases following the p-n junction voltage temperature dependency of seen in the diode factor *qkT*. Solar cells therefore have a negative temperature coefficient of *OC V* (β). Moreover, a lower output power results given the same photocurrent because the charge carriers are liberated at a lower potential. Using the convention introduced with the Fill Factor calculation, a reduction in *OC V* results in a smaller theoretical maximum power *max P* □ *SC I* □*OC V* given the same short-circuit current *SC I* [8].V As temperature increases, again the band gap of the intrinsic semiconductor shrinks meaning more incident energy is absorbed because a greater percentage of the incident light has enough energy to raise charge carriers from the valence band to the conduction band. A larger photocurrent results; therefore, Isc increases for a given insolation, and solar cells have a positive temperature coefficient of *SC I* (α).

3.2 Energy Conversion Efficiency

A solar cell's energy conversion efficiency (*η*, "eta"), is the percentage of power converted (from absorbed light to

electrical energy) and collected, when a solar cell is connected to an electrical circuit. This term is calculated using the ratio of the maximum power point, *Pm*, divided by the input light irradiance (*E*, in W/m2) under standard test conditions and the surface area of the solar cell (*Ac* in m2) The efficiency of energy conversion is still low, thus requiring large areas for sufficient insulation and raising concern about unfavorable ratios of energies required for cell production versus energy collected [12]. In order to increase the energy conversion efficiency of the solar cell by reducing the reflection of incident light, two methods are widely used. One is reduction of the reflection of incident light with an antireflection coating, and the other is optical confinements of incident light with textured surfaces. They showed that the transformation of the wavelength of light could significantly enhance the spectral sensitivity of a silicon photodiode from the deep UV and through most of the visible region

3.3 Maximum Power Point Tracking

Currently, the electricity transformation efficiency of the solar cells is very low that reach about 14%. The efficiency of solar cells should be improved with various methods. One of them is maximum power point tracking (MPPT) which is an important method. The MPPT operates with DC to DC high efficiency converter that presents

an optimal and suitable output power When the output voltage of the photovoltaic cell array is very low, the output current changes little as the voltage changes, so the photovoltaic cell array is similar to the constant current source; when the Voltage is over a critical value and keeps rising, the current will fall sharply, now the photovoltaic cell array is similar to the constant voltage source. As the output voltage keeps rising, the output power has a maximum power point. The function of the maximum power tracker is to change the equivalent load take by the photovoltaic cell array, and adjust the working point of the photovoltaic cell array, in order that the photovoltaic cell array can work on the maximum power point when the temperature and radiant intensity are both changing

Iv. Conclusions

This paper examine factors that affecting efficiency of solar cells. These are changing of cell temperature, using the MPPT with solar cell and energy conversion efficiency for solar cell. Temperature effects are the result of an inherent characteristic of solar cells. They tend to produce higher voltage as the temperature drops and, conversely, to lose voltage in high temperatures. The energy conversion efficiency is increased by reducing the reflection of incident light. The function of the maximum power tracker is to change the equivalent load take by the solar cell array, and adjust the working point of the array, in order to improve the efficiency. Changing of these factors is very critical for solar cell efficiency. The optimum factors make it possible to get the great benefits of solar electricity at a much lower cost.

REFERENCES

[1] "Reporting Solar Cell Efficiencies in Solar Energy Materials and Solar Cells," *Solar Energy Materials & Solar Cells*, Elsevier Science, 2008.
[2] R.-J. Wai, W.-H.Wang and C.-Y. Lin, "High-Performance Stand-Alone Photovoltaic Generation System," *Proceedings of IEEE Transactions on Industrial Electronics*, Vol. 55, No. 1, January 2008.
[3] A. Goetzberger, C. Hebling and H.-W.Schock, "Photovoltaic Materials, History, Status and Outlook," *Materials Science and Engineering*, Vol. 40, 2003, pp. 1-46.
[4] February 2010. http://www.rise.org.au/info/Education/ SAPS/sps003.html
[5] February 2010. http://science.nasa.gov/headlines/y2002/ solarcells.html
[6] X.-J. Ma, J.-Y.Wu, Y.-D.Sun and S.-Q. Liu, "The Research on the Algorithm of Maximum Power Point Tracking in Photovoltaic Array of Solar Car," *Vehicle Power and Propulsion Conference, IEEE*, 2009, pp. 1379-1382.
[7] N. M. Pearsall and R. Hill, "Photovoltaic Modules, Systems and Applications," In: M. D. Archer, and R. Hill, Eds., *Clean Electricity from Photovoltaics*, World Science, Vol. 1, 2002, pp. 1-42.
[8] February 2010. http://alumni.media.mit.edu/~nate/AES/ PV_Theory_II.pdf
[9] Y. Suita and S. Tadakuma, "Driving Performances of Solar Energy Powered Vehicle with MPTC," *IEEE*, 2006.
[10] February 2010. http://www.altestore.com/howto/Solar- Power-Residential-Mobile-PV/Off-Grid-Solar-Systems/Electrical-Characteristics-of-Solar-Panels-PV-Modules/a87/
[11] February 2010. http://en.wikipedia.org/wiki/Solar_cell
[12] H. J. Queisser and J. H. Werner, "Principles and Technology of Photovoltaic Energy Conversion," *Solid-State and IntegratedCircuit Technology*, October 1995, pp. 146-150.
[13] T. Maruyama, Y. Shinyashiki and S. Osako, "Energy Conversion Efficiency of Solar Cells Coated with Fluorescent Coloring Agent," *Solar Energy Materials &Solar Cells*, Elsevier Science, 1998.
[14] M. Nishihata, Y. Ishihara and T. Todaka, "Presumption of Solar Power Generation Corresponding to the Change of Solar Spectrum, Photovoltaic Energy Conversion," *Proceedings of the* 2006 *IEEE* 4*th World Conference*, Vol. 2, May 2006, pp. 2168-2171.
[15] S. Capar, "Photovoltaic Power Generation for Polycrystalline Solar Cells and Turning Sunlight into Electricity Thesis," Engineering Physics, University of Gaziantep, July 2005.

