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Solar Power Analysis Based On Light Intensity

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ABSTRACT
The recent decades have seen the increase in solar power demand for reliable and clean sources electricity**.** The generation of solar power is based on the sun rays intensity on the solar panel and the wavelength. The challenge in solar power plant to maximize the wavelength of the rays from the sun and minimize the temperature effect on the Panel. This paper analysis the solar panel based on different wavelength based Light intensity.

KEYWORDS : *efficiency, solar power, , tracking, sun rays, intensity, solar panel,*

I. INTRODUCTION

The conversion of solar light into electrical energy represents one of the most promising and challenging energetic technologies, being clean, silent in continuous development, and reliable, with very low maintenance costs and minimal ecological impact. The energy from is free, practically inexhaustible, and involves non polluting residues or greenhouse gases emissions.[3] The conversion principle of solar light into electricity, called PV conversion. The PV conversion is not very new, but the efficiency improvement of the equipment is still one of top priorities for many academic and/or industrial research groups all over the world[3]. Light is combination of different colors. The light which we can see is called visible light and has colors from purple to red as shown in Fig-1. These different colors of light have different wavelengths and energies. There is also a lot of light that our eyes can't see! Light that is lower in energy than visible light we call **Infrared** or **IR** light. Your task is to determine what colors of light from a lamp and from sunlight work in a solar cell[1].

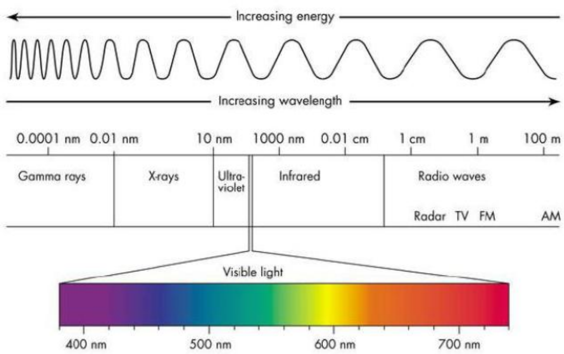

Fig:-1 Light spectrum based on wavelength

In this paper we are simulating the solar panel based on the different colors like Red, Blue and green to change the wavelength on the panel and observing the output of panel based on wavelength & temperature. This paper is organized as follows. Section II outline the different factor for wavelength spectrum. Section III It will explain the effect of temperature on the solar panel. Section IV Result analysis based on wavelength and temperature .Finally V draws the conclusions.

II. WAVELENGTH

Wavelength is the distance between identical points in the adjacent cycles of a waveform in space or along a wire, as shown in the illustration. in the case of infrared ,visible light ,ultraviolet, and gamma radiation, the wavelength is more often specified in nanometer or angstrom units.The visible spectrum is the portion of the electromagnetic spectrum that invisible to the human eye. Electromagnetic radiation in the following range of wavelengths is called visible light or simply light. A typical human eye will respond to wavelengths from about to 390 to700nm.

a. Energy of photon : A photon is characterized by either a wavelength, denoted by λ or equivalently an energy, denoted by E. The relationship between the energy of photon (E) and the wavelength of light(λ) given by the equation:

$E=hc/\lambda$
Where
H(planck's constant)=$6.626*10^{-34}$ joules
C(speed of light)=$2.998*10^{8\ m/s}$

b. Photovoltaic cell making use of light energy : The silicon atoms in a photovoltaic cell absorb energy from light wavelengths that roughly correspond to the visible spectrum. The cell made up silicon, which is mixed with two different impurities that produce positive and negative charges. Light causes the charges to move the electrons and producing an electric current. Material containing different impurities charges for different the wavelengths. The photovoltaic cell does not convert complete light into electric charge, even if it's at the right wavelengths. Some of the energy becomes heat and some reflects off the cell's surface.

c. Spectral response : Spectral response is the ratio of the current generated by the solar cell to the power incident on the solar cell. Spectral response curve is shown bellow. the ideal Spectral response limited at long wavelengths by the inability of the semiconductor to absorb photon with energies below the band gap. Any energy above the band gap energy is not utilized by the solar cell and instead goes to heating the solar cell. the inability to utilize the incident energy at high energies and the inability to absorb low energies of light represent a significant power los in solar cells consisting of a single p-n junction.

III. EFFECT OF TEMPERATURE ON PV PERFORMANCE

- Solar cells output change with temperature changes. The change in temperature will affect the power output from the cells.
- Increase in temperature will decrease the voltage.
- The current increase with temperature due to decrease in the band gap of si.
- The increased cell temperature results decrease in the open circuit voltage due to increase in reverse saturation current.
- Peak power decreases with increase in module temperature

While it is important to know the temperature of a solar PV panel to predict its power output, it is also important to know the PV panel material because the efficiencies of different materials have varied levels of dependence on temperature. Therefore, a PV system must be engineered not only according to the maximum, minimum and average environmental temperatures at each location, but also with an understanding of the materials used in the PV panel. The temperature dependence of a material is described with a temperature coefficient. For polycrystalline PV panels, if the temperature decreases by one degree Celsius, the voltage increases by 0.12 V so the temperature coefficient is 0.12 V/C[2]. The general equation for estimating the voltage of a given material at a given temperature is:

$$V_{OC,ambient} = Temperture\ cofficient \times (T_{STC}[\,^0C] - T_{ambient}[\,^0C] + V \quad (1)$$

a. PV Module Efficiency as a Function of Operating Temperature

The solar cell power conversion efficiency can be given as:

$$\eta_c = \frac{P_{max}}{P_{in}} = \frac{I_{max} \times V_{max}}{I(t) \times A_c} \quad (2)$$

Where I_{max} and V_{max} are the current and voltage for maximum power, corresponding to solar intensity ($I_{(t)}$)and AC is Area of solar cell (Tiwari and Dubey., 2010). The correlations expressing the PV cell temperature (Tc) as a function of weather variables such as the ambient temperature (T_a), solar radiation ($I_{(t)}$), etc. will be discussed in this section. The effect of temperature on the electrical efficiency of a PV cell/module can be obtained by using the fundamental equations.[4]

The basically effect leads to a relation in the form:

$$\eta_c = \eta_{Tref}[1 - \beta_{ref}(T_c - T_{ref}) + \gamma \log_{10} I(t)] \quad (3)$$

In which η_{Tref} is the modules electrical efficiency at the reference temperature, $\mathbf{T_{ref}}$, and at solar radiation of 1000W/m2. The temperature coefficient, **βref**, and the solar radiation coefficient, , are mainly material properties, having values of about 0.0045K and 0.12, respectively, for crystalline silicon modules[5] [4] The quantities η_{Tref} and **βref** are normally given by the PV manufacturer. However, they can be obtained from flash tests in which the module's electrical output is measured at two different temperatures for a given solar radiation flux[6][4]. The actual value of the temperature coefficient, in particular, depends not only on the PV material but on Tref as well. It is given

by the ratio:[4]

$$\beta_{ref} = \frac{1}{T_o - T_{ref}} \quad (4)$$

In which T_0 is the (high) temperature at which the PV module's electrical efficiency drops to zero[7][4]. For crystalline silicon solar cells this temperature is 270 °C [8][4].

For variations in ambient temperature and irradiance the cell temperature (in ^oC) can be estimated quite accurately with the linear approximation[9][4]

$$T_c = T_a + \frac{T_{NOCT} - 20}{0.8\ \mathrm{kw/m^2}} \times I(t) \quad (5)$$

If substitute equation (5) in equation (3) we will obtain important equation (6):[4]

$$\eta_c = \eta_{ref}[1 - \beta_{ref} \times [T_a - T_{ref} + (T_{NOCT} - 20) \times \frac{I(t)}{I(t)_{NOCT}}] + \gamma \log_{10} I(t)] \times 100$$

IV. SIMULATION RESULTS

a. Intensity effect on PV Panel : We are simulating PV panels w.r.t different on the simulation machine by using two 12V panels. Each color have different wavelength as shown in Table:1. By different color we are finding out the Light intensity, voltage and current values of the panel as shown below Figure-1

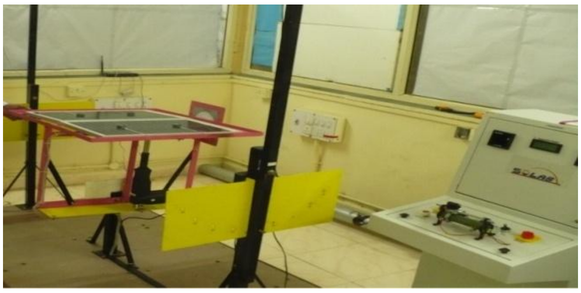

Fig: 1 Simulation Machine

Table-1 Based on color wavelength, intensity and Voltage & current of PV Panel

Color of the acrylic sheet	Wavelength(nm)	intensity	voltage	current
Red	650	78	15.0	0.56
Yellow	580	150	16.5	0.57
Blue	445	119	9.1	0.31

Calculate the power & Spectral Response based on the light intensity and wavelength as shown in Table-2
Where w is the Power of light falling on the panel

Table-2 Color Vs Power & spectral Response of PV panel

Color of the acrylic sheet	Power of light falling on the panel(pin)=intensity of light*area of panels	Spectral response(A/W)=current/pin
Red	78*0.31=24.18	0.023
Yellow	150*0.31=46.5	0.01
blue	119*0.31=36.89	0.008

As we shown in Fig-2 graph the Power is increasing based on the different colors wavelength and Fig-3 shown the Power Vs Spectral Response of the PV Panel.

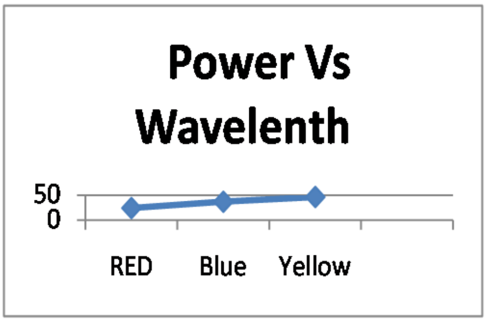

Fig-2 Power Vs Color with different wavelength

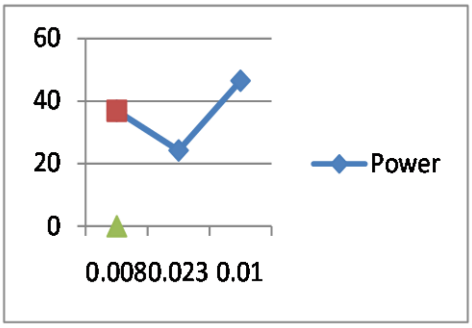

Fig-3 Power Vs Panel Response

From Fig-2 and Fig-3 the Power generation is depending on the light wavelength. As the wavelength are increasing power also increasing.

V. CONCLUSION

In solar systems maximum efficiency can be obtained if the sun rays wavelength is more and the temperature on the Panel surface is less. This is obtained by using the different color of light spectrum and we can minimize the panel surface by using some culling method like water circulating methods. From the results we can conclude that the efficiency of panels can improve if the wavelength of light is increasing and temperature on panel body is decreasing .

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