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Atmospheric Influence on the Characterization of Photovoltaic Cell

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Abstract— *The power generation of a polycrystalline type of photovoltaic cell is analyzed through a characteristic study. The atmospheric influence, such as light intensity and atmospheric temperature, on the photovoltaic cell being analyzed. It is found that atmospheric temperature is greatly influenced by the light intensity. The power output, current output and voltage output of PV cell are addressed in the context of atmospheric temperature.*

Keywords— *PV cell, current output, voltage output, power output, light intensity, atmospheric temperature.*

I. INTRODUCTION

Sun, the ultimate source of energy, is been continuously emitting electromagnetic radiation in which it is possible to distinguish the range of different types depend upon their characteristic difference.

Transforming such rays from the sun into energy is of current need and interest worldwide. Conversion of radiation energy into useful electrical energy require a photovoltaic cell, the 'solar cell', which is widely used from cottage to large scale industries.

Now a days, photovoltaic cells become an integral part of any stable construction. Due to global warming by emission of green house gases, utilization of photovoltaic cells becomes more popular. Its pollution free nature got its name, green energy. An addition to other renewable energy sources such as wind energy, water energy, biomass energy, tidal energy and geothermal energy, Solar energy rank top in utilization and applications [1-2].

It is stated in references [3-5] that increasing the development and utilization of solar energy resources cannot only alleviate the pressure of economic growth on the environment and ecology to the great extent but also slow down the high-speed consumption of fossil fuel which is of far-reaching significance for the clean and the sustainable development of energy [6-7]. In fact, the research on solar energy utilization technology began in 1960s. A long period of research yield matured technologies in applications and which are being used in numerous commercial applications [8].

Since the traditional fuel energy is declining day by day searching for new energy is an urgent issue and solar energy has become the focus of attention due to its unique advantages, such as cleanliness, safety, resource versatility and adequacy. Hence solar power become the most important energy source in the 21st century.

Depending upon the colour of the photovoltaic cell the efficiency and utility differs. As such, two different coloured photovoltaic cells are popularity used; Black and Blue, a monocrystalline and polycrystalline kind of solar panels, respectively.

In recent years, with the support of industrial policies and financial assistance, such as CSR (Corporate Social Responsibility of industries) the research on photovoltaic system has gradually speeded up to meet the conditions for large-scale commercial development. In due course the cost of solar power generation becomes cheaper than other energy generation system and which will replace other renewable energy sources [9].

In the application research of solar cells, it is customary to characterize the solar cell manufactured either by monocrystalline or polycrystalline through the analysis of impact of light intensity in power generation and the role of atmospheric temperature on it.

Hence in this work it is proposed to conduct a characteristic study of solar cell made of polycrystalline on a special day of astronomical importance. Therefore, the experiment is performed on 2ndMarch 2023, the day of conjunction of Venus and Jupiter. The experimental method is discussed in section II and in section III, we discuss the data generated during the day of observation.

Photograph taken on 2nd March 2023, the event of conjunction of Venus and Jupiter

II. METHODOLOGY

The radiation impact on the biospheric surface atmosphere may have the influence of seasonal variation especially the surface temperature and intensity of primary cosmic rays

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reaching the surface of the earth. Many researchers have published articles on the characteristic study of solar cell [10; and the reference therein].

To have a special reference to the measurement of light intensity and thus for PV cell characteristic study we have selected a date of measurement on the conjunction of Venus and Jupiter, the 2nd March 2023. In fact, Venus and Jupiter will continue edging towards each other until they come extremely close basking each other's celestial warmth.

Hence to perform a characteristic study of blue coloured polycrystalline photovoltaic cell this experiment is planned to perform at Kanchi Mamunivar Government Institute for Postgraduate Studies and Research, Lawspet, Puducherry (attitude -11.961030; latitude-79.814568) (GPS Coordinates 11° 57' 39.708" N - 79° 48' 52.4448" E) and the study location is very close to the sea (2500 meter from Bay of Bengal).

A Photovoltaic cell of six panel sheet is been taken and output voltage of one cell of size 7 × 7 cm is recorded on March 02, 2023 at 15 minutes interval till the cell shows a very less output at the time approaching darkness.

The Lux Meter is set for measuring the intensity at normal atmospheric condition. A digital thermometer is been accommodated for recording atmospheric temperature. The panel is adjusted every time to face the Sun for more normal incidence. The whole experimental set up is shown in Fig: 1.

Fig. 1. Solar panel setup for characterization.

III. RESULT

The impacts of solar ray on the atmosphere at different levels depend on the materialistic nature of surface of the earth. It is well known that the secondary radiation on the biosphere may have severe impact due to the presence of materialistic object in the study location. At the same time the primary cosmic rays and its impact cannot be underestimated.

For example, the gravity induced changes in ozone layer causes more cosmic rays to pass through during special astronomical events [11- 15].

Hence this experiment performed on the special day of an astronomical importance, the 2nd March 2023 must attract special attention among the scientific community and the freelance astronomical researches. The data is recorded from 9:45 a.m. to 5:00 p.m. at the Institute Courtyard where there is clear sunlight throughout the day. On the day of observation, the light intensity varied from ≈ 20000 Lux to 90000 Lux (Fig.-2), accordingly atmospheric temperature also varied (Fig.-3).

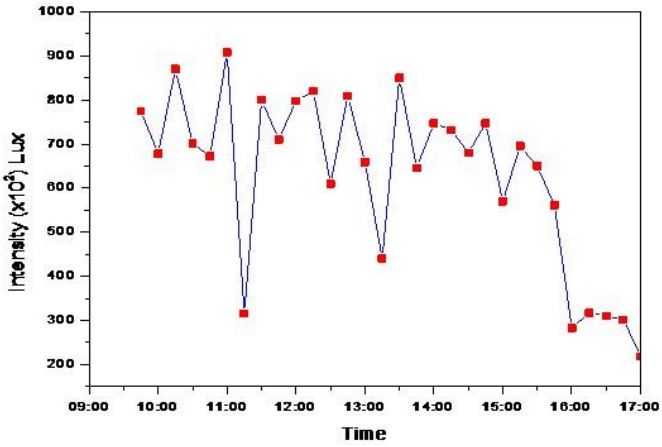

Fig. 2. Solar light intensity recorded on 2nd March 2023 at KMGIPSR.

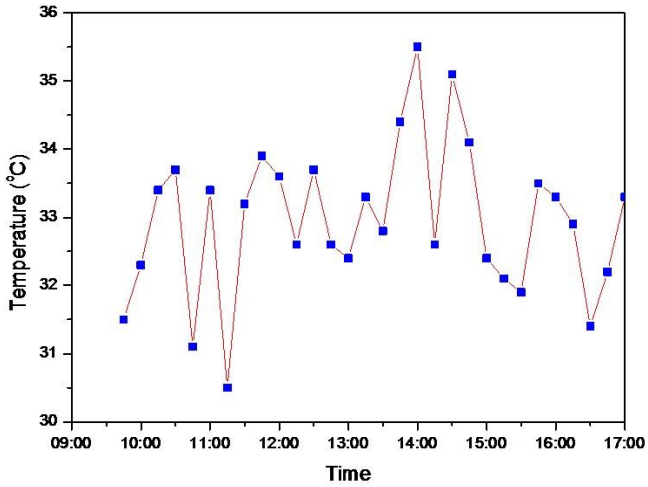

Fig. 3. Atmospheric temperature recorded on 2nd March 2023 at KMGIPSR.

At 11:15 a.m. a sudden cloud formation was observed which reduced the light intensity reaching the surface of the study location to ≈ 30000 Lux from 90000 Lux, which is evidenced from the (Fig.-2); accordingly, temperature also reduced from 33.5°c to 30.5°c (Fig. -3).

After 12:00 noon the variation of light intensity and temperature are proportional and around 5 p.m. in the evening, the intensity of light was reduced to < 20000 Lux.

It is quite interesting to observe the similarity of light intensity and output voltage measured, which is evidenced from Figs. (2 & 4).

The voltage variation is more or less coinciding well with the intensity recorded, which shows the direct relation between intensity and output voltage [16]. The output current measured fits with Gaussian that is when time increases its current output decreases (Fig.-5).

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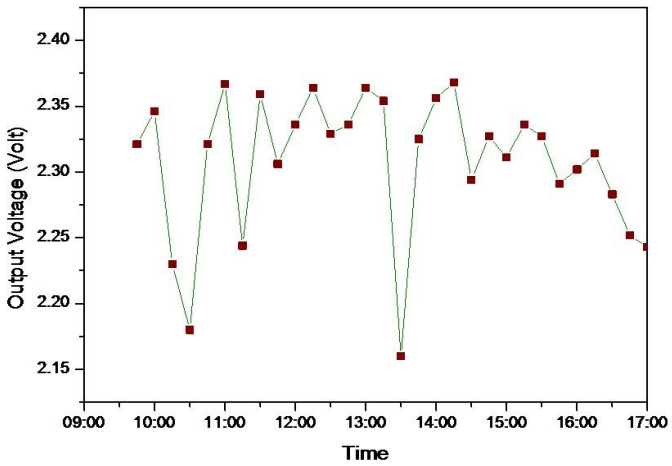

Fig. 4. The output voltage of a single photovoltaic cell exposed to direct sun light.

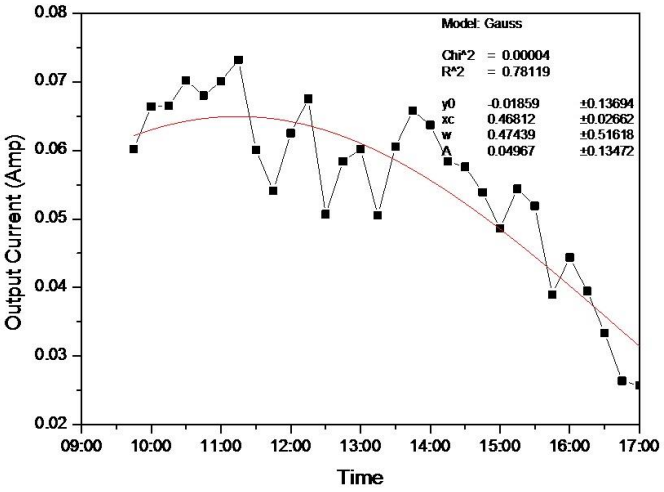

Fig. 5. The output current of a single photovoltaic cell exposed to direct sun light.

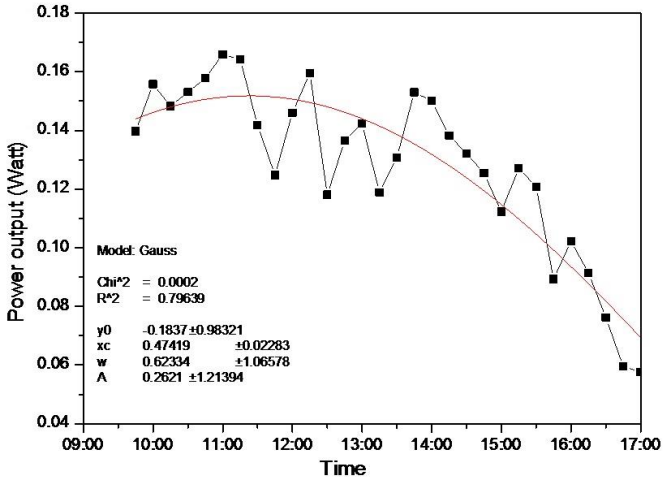

Fig. 6. The power output of solar cell calculated from the measured voltage and current.

From the measured output voltage and output current the power output is calculated and plotted in (Fig.-6) which also shows a Gaussian nature and which reveals the impact of light on generating power and this increases till noon and decreases to approaching darkness.

The power versus current (Fig.-7) data fits linearly and which shows the measurement done for this work is comparatively more accurate at low current and at higher values of current a very little power fluctuation is observed.

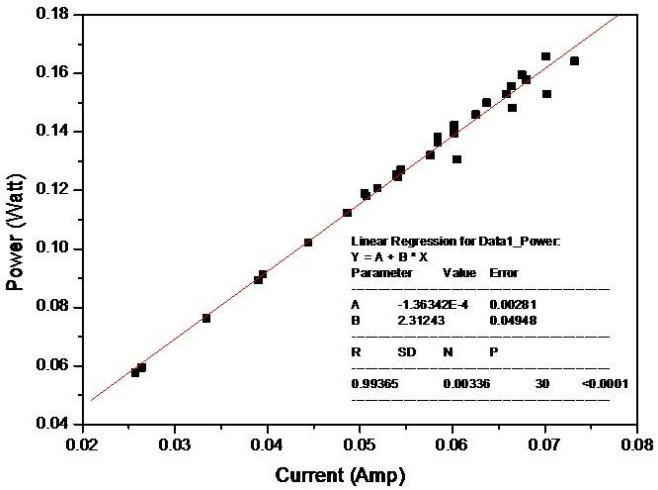

Fig. 7. The proportionality of current to power measured for a single solar cell.

As a result of this study, it is recorded that the impact of light intensity and the generation of power output by the PV cell are proportional to each other (Fig.-8).

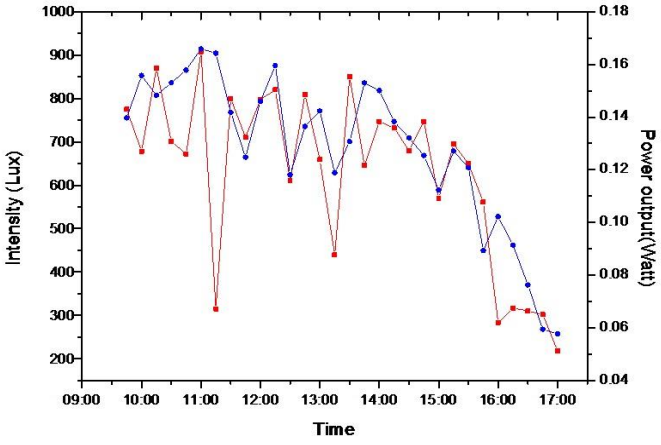

Fig. 8. The role of intensity in power output of a PV cell.

A systematic measurement through a period of time in all seasons may reveal a good result of atmospheric influence in the characteristics of a PV cell.

IV. SUMMARY

The power generation by a PV cell is being analyzed through the characteristic study. Through this study the following findings are arrived.

i. The power generation of a PV cell varies with solar light intensity.
ii. The atmospheric temperature is greatly influenced by the light intensity.

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iii. The power generation of a PV cell will be maximum upto 3:00 pm during sunny days.
iv. The output current and thus calculated power output fits with Gaussian.
v. Hence the output voltage is nearly constant with a maximum variation of ≈ 0.1 V throughout the day.

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