



### Humid Free Efficient Solar Panel

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**Abstract:** The paper discusses the effect of the humidity on the Solar panel which creates a room for the drastic variation in the power generated and makes the device less efficient. Humidity readily affects the efficiency of the solar cells and creates a minimal layer of water on its surface. It also decreases the efficiency by 10-20% of the total power output produced therefore, to tackle this issue, well defined measures are required to be taken to assure the smooth working of the solar panels used in various humid areas. In connection with this issue, Karachi, the biggest city of Pakistan which is located near the costal line touching Arabian Sea, was taken as a reference city to measure the humidity range. In Karachi, the average humidity lies between 25-70% (as per Pakistan Meteorological Department PMD), that indirectly leads in decreasing power acquired from a Solar Panel and develops various complexities for the solar system. The system on average experiences stability issues, such as those of power fluctuations etc., due to which, the whole solar system installed observes abnormal variations in acquired power. Silica Gel was used as a desiccant material in order to assure dryness over the solar panel. More than four experiments were conducted with the usage of water absorbent to improve the efficiency and to make system more power efficient.

**Keywords:** Solar Energy, Water Absorbent, Efficiency, Humidity, Solar Panel.

## 1. INTRODUCTION

In the recent years, conventional fossil fuel have resulted in the increasing number of environmental problems and have created a big room for the researchers to ponder over renewable energy sources to replace those over nonrenewable. It is important to switch to renewable energy sources to preserve green environment and prevent environmental problems. Many countries have introduced a straight policies over covering the energy aspects from the Renewable sources. In this prospects, various countries have redefined their policies forward for the adjustment of proportion of new energy planning and utilization.

It is important to notice that the application of Solar Energy is the fastest growing in the recent years among all available renewable energy sources, and correspondingly it offers a dynamic aspects for further research. Furthermore, it is also an important thing to notice that Efficiency of the Solar Panels have always offered challenges for the researcher to work on as this parameter contribute the best to the payback time for overall investment for any laymen installing a Solar System for the energy requirements.

Solar Energy can be defined as the energy that is received from Sun in the form of sunlight and is converted to various forms such as Electrical Energy or Thermal Energy Etc. The energy that is harvested in the

form of Electrical Energy makes use of Photovoltaic effect to convert the radiant rays of sunlight into respective potential difference. Photovoltaic effect is the phenomenon which absorbs photons in the light and generates electron hole pair which is responsible for creating a potential difference. Solar cell is a device which incorporates the Photovoltaic effect and generates a potential difference by absorbing photons of the light which has enough energy to get a crystal's atom form an electron hole pair. The electronics and the holes are in Brownian motion through the lattice, and once an electric field is introduced, they will separate and combine with the poles according to their electric charge i.e. Electrons towards Anode and Holes towards Cathode as cited by Wolfgang *et al.* (2010).

The process of energy conversion depends on the amount of solar irradiance which is the measure of the power/unit area that is received from the sun in the form of electromagnetic radiation. The value of solar irradiance depends on the instrumental working wavelength which actually it operates. There is continuous variations observed in the value of solar irradiance reaching the Earth's surface because of various reasons. One of the major reason that constitutes the drastic variation in the value of the solar irradiance is the location of Earth from the Sun. Another reason can be explained by the external parameters, such as weather conditions as of clouds and atmospheric

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parameters which actually limits the amount of solar irradiance from reaching the Earth's surface.

Solar Radiation is particularly the electromagnetic energy emitted by Sun. About half of the emitted radiation lie in the visible part of the electromagnetic spectrum whereas the other rest part is mostly the near infrared and ultraviolet part of the spectrum. Approximately about 31% of the solar radiations reaching Earth, are reflected back by the clouds, atmosphere and the Earth's surface. There is a direct influence of the atmospheric parameters in limiting the amount of solar radiations reaching the Earth from the Sun as cited by UNEP, Intergovernmental Panel of Climate Change (2001).

Solar Cell Efficiency is the amount of sunlight that is converted in the electrical energy by utilizing the photovoltaic. There are various aspects of Efficiency degrading which mainly depending on the construction of the solar modules' response of various frequencies of light as cited by US Department of Energy (2009). If we emphasize on the response of the Solar Module's over the near infrared and ultraviolet range of solar radiation, they appear to not cover the ranges for the power production and the range doesn't contribute to the systems power efficiency. Because of the external parameters, there can be a change in the maximum power point which can indirectly lead to fluctuation in the Power efficiency produced by the solar panel as cited by Mustafa *et al.* (2009) and also cited by Alonso *et al.* (2006).

Due to Humidity in areas which are near to coast, the corresponding values of water vapors in the atmosphere encourages more losses in the Solar Radiations reaching at the surface of the Solar Panel. Additionally, with higher values of humidity, there appears a minimal amount of water molecules/layer which forms on the surface of the solar panel, thus encouraging more amount of losses in the process of absorption, reflection and refraction of the solar radiation from the surface of the solar panel. When the light energy consisting of photons strikes the water layer which in fact is denser it causes refraction. This results in decreasing of intensity of the light which in fact appears to be the possible cause of decrease in power efficiency (ratio of generated electrical power per the incoming radiated light). Additionally there appears a minimum component of reflection also because of which, minor proportion of light is reflected back into the atmosphere, thus not being useful in the conversion process as cited by Tiwari *et al.* (2012) and also cited by Chegaar *et al.*, (2013).

The manufacturers of Solar Panels report in the specification sheet that the Panel responds at  $1000\text{W/m}^2, 25^\circ\text{C}$ . However, the performance of the Solar Panel is strongly affected by various external factors and which may cause the Panel to deviate from the standard values as prescribed by the manufacturers. With the corresponding rise in the Humidity, there are various parameters that are effected which indirectly lead in reduction of power efficiency of a Solar Panel as cited by Gottschalg *et al.* (2001).

Desiccant materials are those which are used to induce and sustain the dryness of any area. These materials can be used to absorb moisture and can also be incorporated in high mechanical environment to keep the machine moisture free. Their relative usage criteria is also high because of which they can offer high amount of reusability with limited budget as cited by Otto *et al.* (2008).

## 2. MATERIALS AND METHODS

A colorless water absorbent desiccant Silica Gel was used to cover the endings of Solar Panel. The Desiccant was incorporated in such a way that it could cover the major area of the solar panel.

Because of change in the external parameters, we had taken a lab into consideration and had maintained environment such that to exclude the external parameter's effect on the experiments. It can be noticed, that the intensity of the Sun varies every hour and such as to validate the concept, we had taken a constant light source of Tungsten halogen bulb in order to assure constant light source. The room temperature was  $32^\circ\text{C}$  with Humidity of 25%. The setup was installed which included 50W BP350 Solar Panel Having Specification of  $V_{mp}$  (Maximum Power Voltage)=17.2V,  $I_{mp}$  (Maximum Power Current) =2.91A with temperature coefficient of  $I_{sc}$  =  $(0.065 \pm 0.015) \text{ }^\circ\text{C}$ , Temperature coefficient of  $V_{oc}$  (Voltage Open Circuit) =  $(-80 \pm 10) \text{ mv } / ^\circ\text{C}$  and Temperature coefficient of power =  $(-0.5 \pm 0.05) \text{ } \% / ^\circ\text{C}$ . 2 Feet was the distance that was maintained between a halogen bulb and a solar panel. Humidifier Vicks Brand was used to increase the humidity of the lab in order to validate the concept. Hygrometer of Any meter brand was used to properly calibrate and calculate the value of humidity in experiment. Tungsten filament bulb of value 15/20/25 Watts were used to offer a load to the system.

### 2.1 Experiments without Absorbent:

The experiment was first conducted without applying colorless hygroscopic material. Value of

humidity was increased and corresponding measured values were noted down. The values of humidity were kept in the range between 25-55% because of the limitation of the Material's ability to re-usage. In order to assure the material's smooth performance, the range was taken into account for the proper calculation of parameters.

## 2.2 Experiments with Absorbent:

Once the above results were obtained, we applied Water absorbent material over the boundaries of the Solar Panel in order to make it utilize its ability of absorbing the humidity over the panel, indirectly absorbing the minimal water layer over the surface of the Solar panel.

In addition to absorbent that was used by keeping in the mind the fact that it appears to be colorless solid and doesn't affect the intensity or the light spectrum at any angle. The below are the results which were obtained after the application of the Water absorbent material on the edges of the Solar Panel.

## 2.3 Repeatability and Error Analysis:

Four experiments of same conditions conducted, it was noticed that there were very few fluctuations observed in the readings and in comparison to those, those experimental readings which were more frequent were taken into account for the proper calculation of power at the output.

## 3. RESULTS AND DISCUSSION

The results obtained from above experiments show a drastic change in the values of voltage current and power. By the comparison made between the experiments made with and without the desiccant material, sufficient accession was noticed which create a high benchmark for usage of different materials for different parameters and regions. The variations and the parameters effects were noticed and were carefully studied.

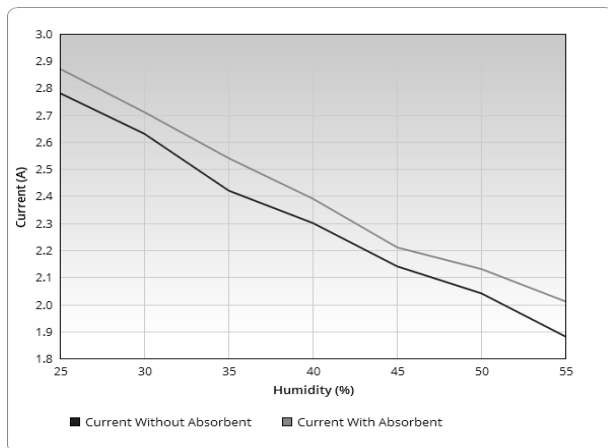


Fig. 1. Influence of humidity on current.

**Fig.1.** Shows the influence of humidity on current with Absorbent and without Absorbent. It can be deduced that with the variations in the humidity, there is subsequent change in current is observed. By using absorbent Silica Gel with the materials ability to dryness of the panel's surface, it allows more electrons to excite to the higher level which indirectly causes more amount of electron hole combination. With the increase in the electron hole combination, there is a subsequent increase observed in the values of current with the Desiccant material. The increase about 2 to 3 A is obtained by using the Absorbent.

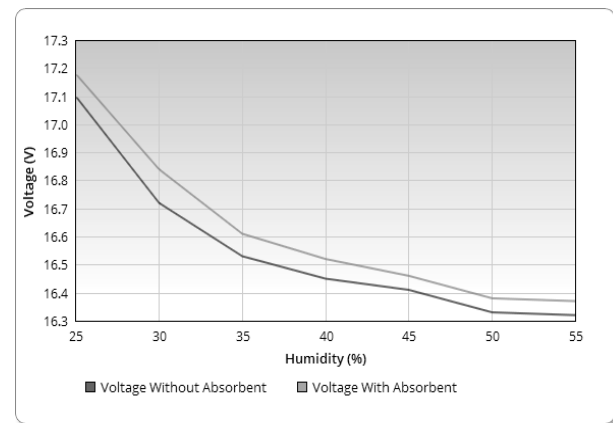


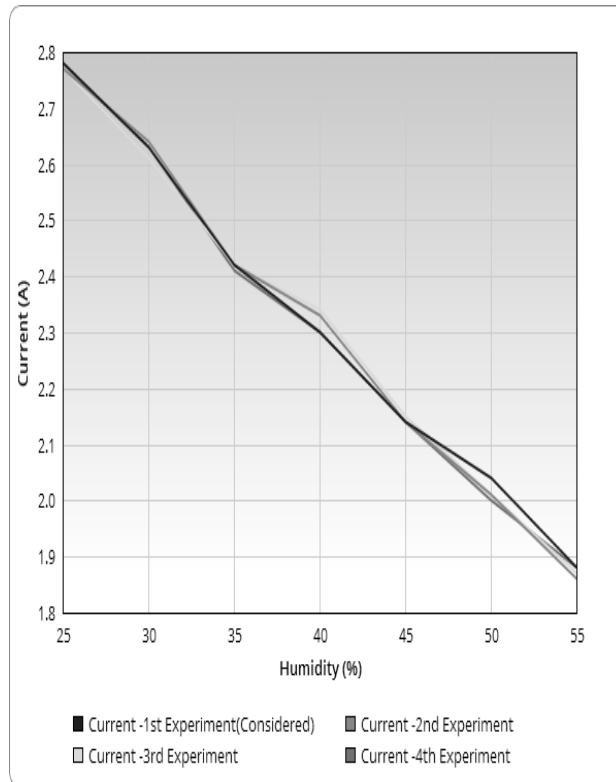
Fig. 2. Influence of humidity on voltage

**Fig. 2.** Shows the influence of humidity on Voltage with Absorbent and without Absorbent. From the Fig. 2, it can be observed that there is a gradual decrease in the voltage as the humidity percentage increases. With the desiccant material usage, that gradual decrease in voltage may be minimized as the usage of absorbent Silica Gel allows more electrons to excite which allow more potential difference in the output across electrical load. Hence a better voltage is always output. The increase about 1 to 1.5 V is obtained by using the Absorbent on the panel surface as compared to the panel which is without absorbent.



Fig. 3. Influence of Humidity on Power output of a Solar Panel

**Fig. 3.** Shows the influence of humidity on power output of a solar panel. From Fig. 3, it can be observed that due to higher excitation of Electrons, the power that is produced is higher in the experimental results with usage of desiccant material to those without desiccant material. A significant increase in power of 3 to 5 W is observed by using absorbent.



**Fig.4.** Repeatability of experiments.

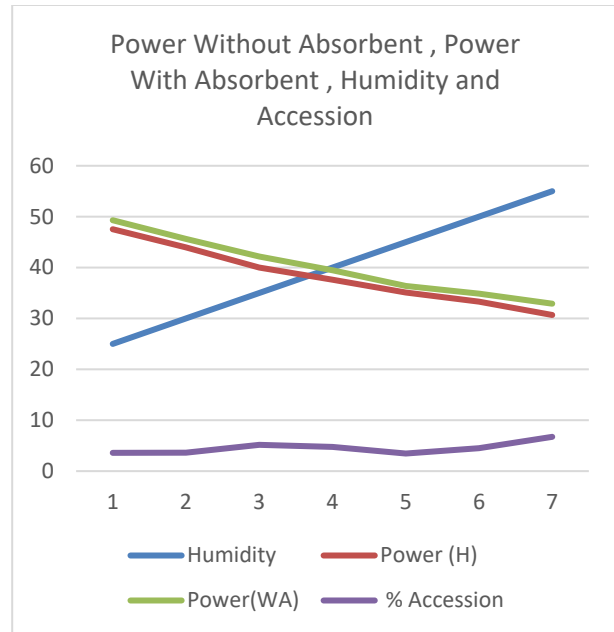
**Fig. 4.** Shows repeatability curves of the experiments conducted of same conditions. The system showed very minute variations in the readings, which is clear in the Fig. 4. The readings noticed in the average of four, were taken into account for calculations. This is how the experiments were assured and got the data with precision.

#### 4. POWER ACCESSION

If we compare the results of the powers, Power (H) and Power (WA) from Fig. 9, the relative difference can be easily seen and the Accession can be noticed with the following formulae.

$$\text{Power Accession in \%} = \frac{\text{Power (WA)} - \text{Power (H)}}{\text{Power (WA)}}$$

Where Power (H) is the power calculated with nominal humidity and Power (WA) is the power calculated with Water absorbent.



**Fig. 5.** Power with Humidity P (H) and with the Water Absorbent P (WA) and the % Accession.

**Fig. 5.** Shows the comparative analysis of the concerned power with Humidity P (H) and with the Water Absorbent P (WA) and the % in the Accession. From Fig. 5, it can be observed that the overall power with the variation in the humidity is accessed with the usage of Desiccant Material. There is irregularity noticed in the value of accession which need more attention on the Desiccant Material's internal properties and their behavior at various ranges of humidity. Furthermore, this aspect of irregularity needs to be studied more in order to assure stability in the systems that might accommodated this idea. There is subsequent increase in the power produced if we compare with the results without water absorbent. There are irregularities in the accession which needs more insights on the behavior of desiccant material with respective increase in the environmental parameters.

#### 5. CONCLUSIONS

The experiments conducted so far revealed that the humidity drastically affects the efficiency of the Solar Panel. The application of Hygroscopic Chemical, a water absorbent element, around the edges of solar panel increases the efficiency of the Solar Panel and hence making the Solar panel utilize the best of the Solar Energy coming from Sun. From the experiments conducted It proved that the Humidity readily decreases the Current and Voltage ratings and indirectly decreases the power output of the device too and with the solution approach it was noticed that the Power between (3-7%) more was accessed/ utilized. 10-15 lines

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