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Studying the weather condition affecting on solar panel efficiency

Yaseen. H. Mahmood , Faris S. Atallah , Ali F. Youssef
Department of Physics, College of Sciences, Tikrit University, Tikrit, Iraq
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Corresponding Author:
Name: Yaseen. H. Mahmood
E-mail: D.yaseen.ph.sc@tu.edu.iq
Tel:

ABSTRACT

Solar energy is one of the most widely used types of renewable energy. Solar panels are more used, but weather factors affect their efficiency. In this research, some factors affecting the efficiency of solar cells were studied. A solar cell of single crystalline silicon have been used. The theoretical efficiency of this cell was about (16.276%), and the practical efficiency of the solar cell itself was calculated when the weather was Cloudy and its surface moistened with rain water, its maximum efficiency (8.5258%). As for when its surface is dry in the same conditions, its greatest efficiency is (14.5703%), and when the atmosphere is clear and the cell surface is covered with dust, its greatest efficiency will be (8.9502%).

1- Introduction

The Solar Energy consider one of renewable energy, that developed increasingly in the past 50 years by a lot of researchers who worked on developing the efficiency of the solar panel or developing the external material to increase efficiency. The German Institute (ZSW) developed the performance of CIGS cells to 12.7% with a (30cm x 30cm) increase in plate production. Later, Cd plates have been advanced with the same dimensions with a overall performance efficiency of up to 10% [1]. The effects of dirt accumulation on solar permeability through distinctive glass panels in which tilt angles were experimentally determined. It has been determined that the weekly cleansing of solar panels is notably encouraged as part of the upkeep routine [2]. photovoltaic conversion efficiency of more than 10% in excessive-silicon sun cells such as a thick layer of up to 2 μm of polycrystalline silicon. It has been observed that sufficient contemporary can be drawn even from the skinny movie because of the effect of very powerful optical friction of silicon with a low absorption coefficient [3]. It has been accounted for that the power misfortune because of residue dirtying broadly happens on sun based vitality frameworks, for example, PV boards or thinking sun based warm influence (CSP) frameworks [4].The handiest manner to improve the overall performance of silicon solar cells. A new scheme for the frontal contact sample of sun cells made of crystalline silicon has been evolved. The software of cross-selective laser doping is applied. this technique does no longer affect the open-circuit and quick-circuit voltage notably, [5] In environmental conditions in Singapore and its effect on optical transport. It changed into observed that for naked glass samples, The end result is much less green in these regions than in inexperienced areas [6]. The buildup of dust or debris inclusive of dirt, water, sand and algae at the floor of solar panels. This is a prime problem and the mild impedance is an outside resistance that reduces solar photovoltaic performance. The experiments had been done using a smooth plate and a plate blanketed with dust, [7]. An advanced cleaning gadget that makes use of electrostatic force to dispose of sand from the floor of sun panels. Where the excessive mono voltage is applied to the parallel cord electrodes embedded in the solar panel cover plate. This method increasing efficiency of big solar energy plants constructed in deserts at low latitudes [8]. Dust can reduce the efficiency of the PV panel by using inflicting bodily damage through mitigating the incoming solar radiation and causing the temperature to rise, leading to modifications inside the solar panel. [9].The temperature on solar panel surfaces and their impact on output performance, mainly efficiency. Under special radiation conditions, there is an excellent surface for sun PV to supply most efficiency. The results of the test also showed that solar photovoltaic

performance should have an expanded charge of up to 47% with the refrigerated kingdom, and the researchers proposed a cooling system of a capability photovoltaic solar device [10].

2- Energy Conversion Efficiency

A solar cell based cell's vitality change proficiency (η), is the level of intensity changed over (from retained light to electrical vitality) and gathered when a sun oriented cell is associated with an electrical circuit. This term is determined utilizing the proportion of the most extreme power point, P_m, isolated by the info light irradiance (p_{in}, in W/m^2) equation (1,2),under standard test conditions and the surface region of the sun based cell (A in m^2) equation (3,4)

$$\eta = \frac{P_m}{P_{in}} = \frac{I_m V_m}{P_{in}} \text{ -------- (1)}$$

$$\eta = \frac{I_{sc} V_{oc} FF}{P_{in}} \text{ ----------(2)}$$

$$FF = \frac{P_m}{V_{oc}} \frac{I_m V_m}{V_{oc} I_l} \text{ ---------(3)}$$

I_m ,V_m : The maximum magnitude of current and voltages

V_{OC} : Open circuit voltages.

I_l : photo generated current LI is equal to the current produced by the cell at short circuit (V = 0)

P_{in} : The power incident .

I_S : The intensity of solar radiation in watt / m^2 unit

η : efficiency of the solar panel .

FF ,is called fill factor solar cell

$$\eta = \frac{P}{A * Is} \text{ ---------(4)}$$

The effectiveness of vitality transformation is still low, consequently requiring huge territories for adequate protection and raising worry about horrible proportions of energies required for cell creation versus vitality gathered [11]. So as to build the vitality change proficiency of the sun oriented cell by lessening the impression of the occurrence light, two strategies are generally utilized. One is the decrease of the impression of episode light with an enemy of reflection covering, and the other is optical containment's of occurrence light with finished surfaces. They demonstrated that the change of the wavelength of light could essentially improve the unearthly affectability of a silicon photodiode from the profound UV and through the vast majority of the obvious district. [12]. The sun based module has an alternate ghostly reaction relying upon the sort of the module. Thusly, the difference in the unearthly irradiance impacts the sunlight based power age [13]. The sunlight based range can be approximated by a dark collection of 5900 K which brings about an expansive range running from the bright to the close infrared. A semiconductor, then again, can just change over photons with the vitality of the band gap with great effectiveness.

3- Method and material

The experimental part which has been done to find the efficiency of solar panel at different circumstance otherwise the solar radiation has been studied by using solar power meter. A single crystalline solar panel of (99x165cm), containing (60) cells, the area of one cell is about 0.0256 m^2 and the panel connected with two Avometers ,One of them is used to measure the voltages (V) and the other to measure the current (I),the load applied on the panel used two lamps with power (60-100) watts the circuit diagram shown in Figure (1).

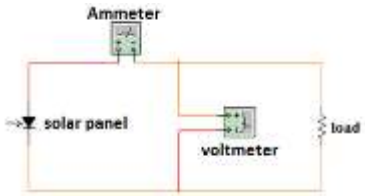

Fig. 1: Experimental circuit for test solar panel.

We study the solar radiation in two month in Salah Alden.

1-The solar panel clean when the weather was in cloudy.

2-The solar panel is dry when the weather is cloudy.

3-The solar panel covered by raining water.

4-The solar panel covered by dust

The accumulation of thin dust on the surface of the solar panel show in figure (2):

Fig. 2: left Solar panel with dust, right Solar panel clean.

4- Result and Discussion

We found the theoretical efficiency of panel and other parameters have been calculated from the equation (1,2,3 ,4), the solar panel and stated in table (1) below:

Table 1:The Solar panel parameters

power	250 Watt
Solar radiation (I_s)	1000Watt/m^2
width of onc cell	0.16 m
Length of one cell	0.16 m
Number of cell	60
Total area	1.536 m^2
Efficiency	16.276

The solar radiation on 21-22/3/2019 at clear day in Salah Alden at longitude (43.242), and latitude (35.492), in figure (3) when show increasing the solar radiation from (7 o'clock Am) starts at (400 W /m^2) to (750W/m^2) at 12 o'clock at mid-day while decreasing to sun set, The reason for the difference solar radiation between two compared day resultant by passing outspread clouds so as to attenuation in radiation [14].

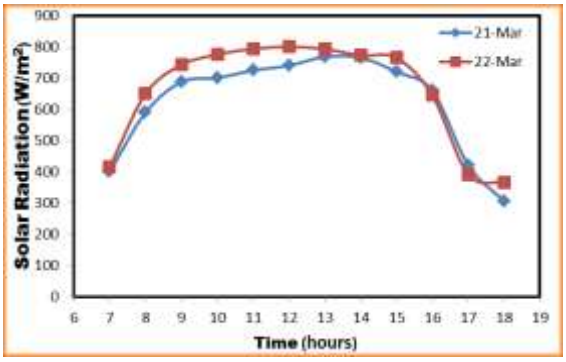

Fig. 3: The change of solar radiation for all time in March (2019)

when measuring the solar radiation in April we found out it decreased compared to march, The reason for the difference in the value of solar radiation for both days is on the first of April's morning it was cloudy, and these clouds blocked a large part of the solar radiation, but when the time is about 10 am these clouds disappeared and thus increased the value of solar radiation to reach about (740.3 W/m^2). Of the blue curve in the figure(4), while on the second day of April, the clouds were thick so it blocked the solar radiation except the limits of the second hour at noon, where the solar radiation is about (613.9 W/m^2) as shown in the curve in red and continues to vary in the appearance and disappearance of the sun until the end today Figure (4) .

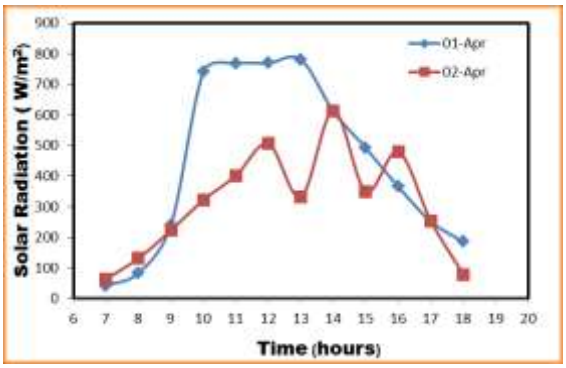

Fig. 4: Relation between solar radiation for all time in April (2019).

The experiment test in 27/4/2019, where the readings of both solar radiation and efficiency of solar panel , in Figure (5,6) we found that the greatest value of the efficiency & power of the surface of the solar panel with wetted by water Rain is (8.5258%), (29.046watt) the smallest value will be (2.5958%), (5.976watt). this because the solar radiation decrease between 10:00 Am to 11:30 Am the voltage and current of solar panel decreasing so as the power and efficiency decrease this because the water rain attenuation and scattering to radiation this agreement with [15,16].

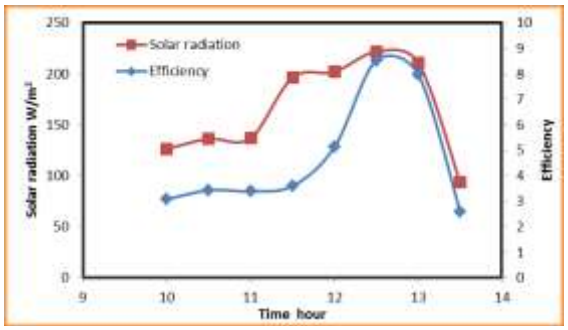

Fig. 5: Relation between the solar radiation and efficiency for all time.

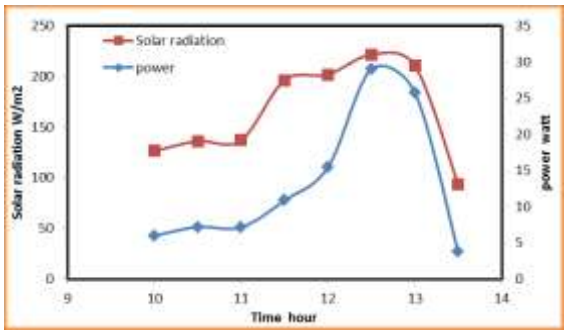

Fig. 6: shows the relationship between the solar radiation and power for all time of the solar cell.

Figure (7) shows that the maximum value of the efficiency & power when the surface of the solar panel is dry, in the cloudy weather is about (14.5703 %), (60.426watt) and the smallest value is (0.07226%), (0.033 watt) ,We see that the maximum efficiency & power of the solar panel in cloudy weather when the dry surface is greater than the maximum value of the efficiency & power of the same solar panel when the surface wet with rain water, because the rain water is not pure because it contains impurities, causing the deposition on The surface of the panel will thus lead to blocking a large portion of solar radiation. The lowest value of the efficiency & power, we find it to be a dry solar panel and because of the accumulation of large clouds that blocked most of the solar radiation without reaching the solar panel [17].

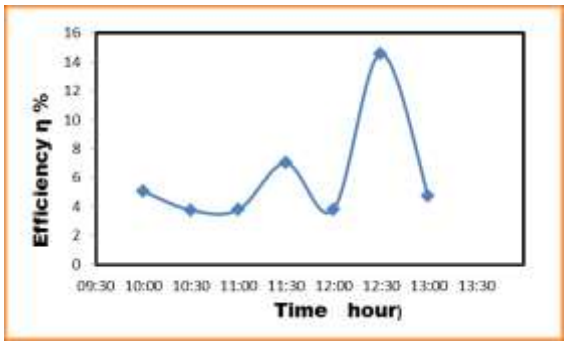

Fig. 7: Relationship between the efficiency for all time of the solar cell.

From we observe that the external power of the clean solar panel is (172.8) watts, which is much higher than the maximum power of the solar panel with dust, which is about (111.94) watts, Figure (8). the efficiency of the clean solar panel, it is almost approaching the theoretical efficiency of the solar cell and is about (14.0625%) and is about one and a half times greater than the solar cell with the presence of dust, which is (8.9502%) .This agreement with [18].

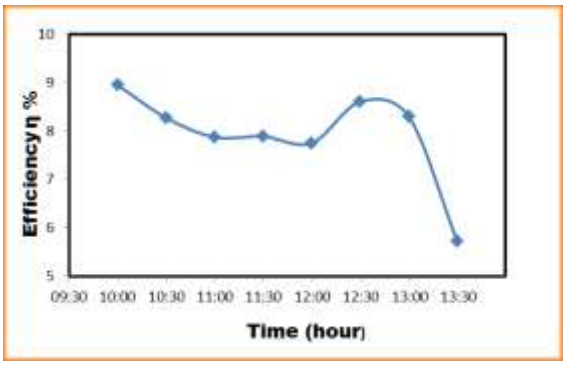

Fig. 8: Relationship between efficiency for all time with dust.

The reason for this is that the dust prevents the influence of the solar radiation of the solar panel and therefore will not reach a large part of this radiation to the cell and therefore will lead to the decline of both capacity and efficiency because the efficiency is directly proportional to the power out of the solar cell [19] .

5- Conclusion

In this work, solar radiation has been tested and measured over time for two months (March & April). when the weather is cloudy and its surface is wet, the efficiency is less than when it was dry .The reason for this is that the solar radiation scattered the solar radiation .Also the electrical parameter decreasing for solar panel when the surface of the panel covered by rain water, and dust to depend on the density of impurities .the solar panel is sensitive to the dust density so it is exceptionally fundamental to give an auto-cleaning system to expel the residue particles from the outside of the solar panel so as to guarantee the elite.

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دراسة العوامل الجوية المؤثرة على كفاءة الاداء للخلية الشمسية

ياسين حميد محمود ، فارس صالح عطا الله ، علي فاضل يوسف

قسم الفيزياء ، كلية العلوم ، جامعة تكريت ، تكريت ، العراق

الملخص

الطاقة الشمسية من اكثر انواع الطاقة المتجددة استخداما، تعد الالواح الشمسية اكثر استخداما ولكن العوامل الجوية توثر على كفاءتها. في هذا البحث تم دراسة بعض العوامل التي تؤثر على كفاءة الخلايا الشمسية ،حيث تم استخدام خلية شمسية من السيلكون احادي التبلور (single crystalline silicon). كانت الكفاءة النظرية لهذه الخلية بمقدار (16.276%) وكذلك تم حساب الكفاءة العملية للخلية الشمسية نفسها عندما كان الطقس غائم وسطحها مبلل بمياه الامطار فان اقصى كفاءة لها (8.5258%). اما عندما يكون سطحها جاف في نفس الظروف فان اعظم كفاءة لها (14.5703%) وكذلك عندما كان الجو صافي وسطح الخلية مغطى بالغبار فأن اعظم كفاءة لها ستكون (8.9502 %) .