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Effect Temperature and Color Filters to Output Power of Single Axes Tracker System in Kirkuk Governorate

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Abstract
Solar energy is rapidly gaining importance as a source of renewable energies. Solar tracker system enables more solar energy to be generated because of the solar panel; the solar panels which receives the largest amount of solar radiation incident when it is perpendicular to the solar panel, solar tracker system is used to increase the output power gain from the solar cell. It was study the output power gain of solar panel in the tracker system and compares them with the fixed panel at a latitude angel (35.47°) of the Kirkuk city. It turned out that the output power increases about (22%) for the month of April compared with the fixed panel. Many factors including temperature and light effect the power gain for panels used in solar tracker system, so it has been studding the effect of temperature and colors filter for the output power from the system it turns out that it decreases with increasing air temperature and the colors filters from polycrystalline solar cells.

1. Introduction

Solar Energy the sun is the only star of our solar system located at its center. The earth and other planets orbit the sun. Energy from the sun in the form of solar radiation supports almost all life on earth via photosynthesis and drives the earth's climate and weather. About 74% of sun's mass is hydrogen, 25%is helium, and the rest is made up of trace quantities of heavier elements. The sun has a surface temperature of approximately 5500K, giving it a white color, which because of atmospheric scattering, appears yellow. The sun generates its energy by nuclear fusion of hydrogen nuclei to helium. Sunlight is the main source of energy to the surface of the earth that can be harnessed via a variety of natural and synthetic processes. The most important is photosynthesis, used by plants to capture the energy of solar radiation and convert it to chemical form. The greatest advantage of solar energy as compared with other forms of energy is that it is clean and can

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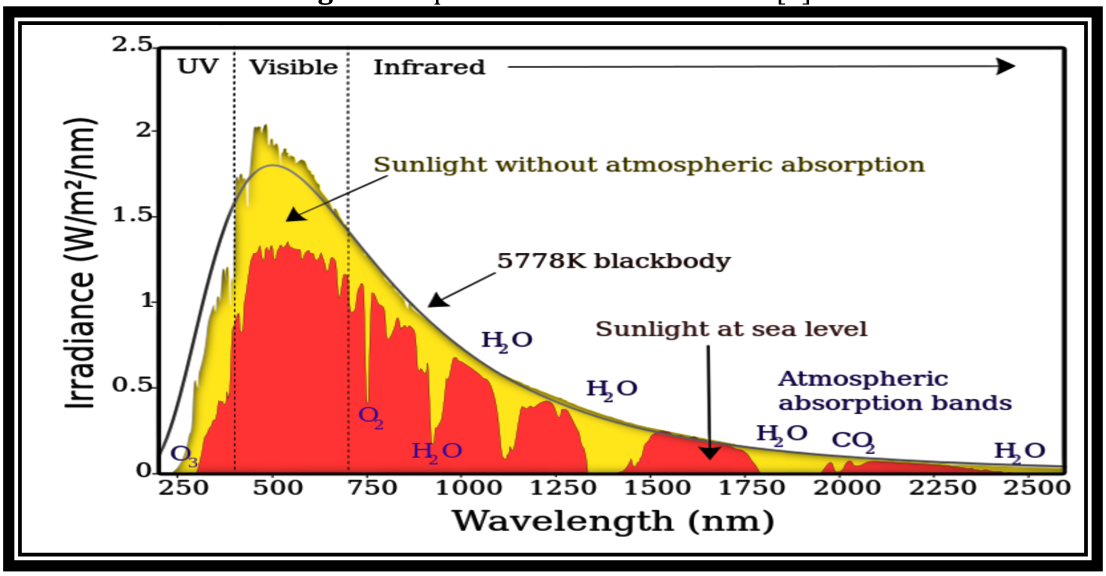
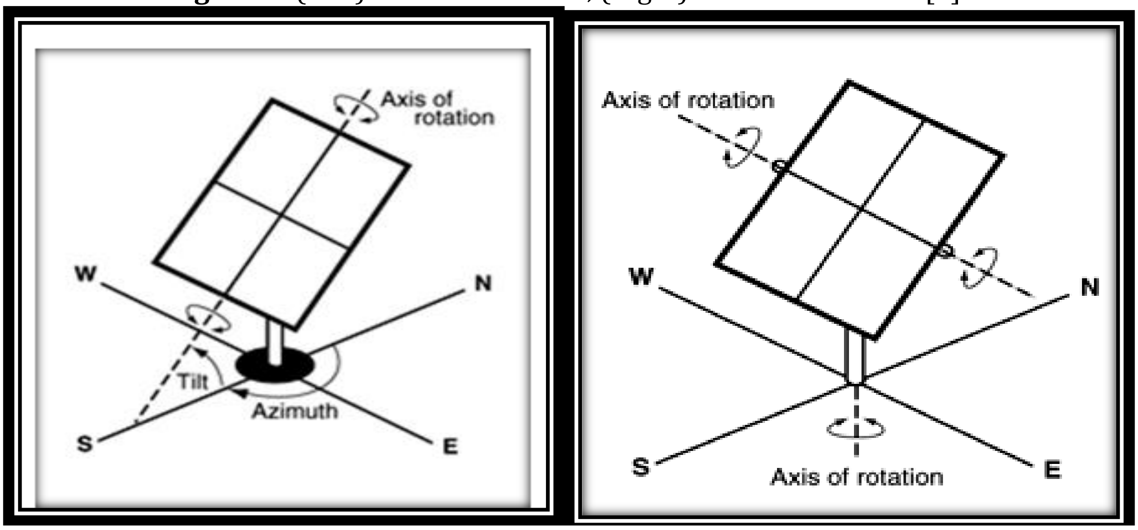
be supplied without pollution [1]. Solar radiation as a function of wavelength distribution is called the solar spectrum, which consists of continuous emission with some superimposed line structures. The total radiation output of the sun and nearly equivalent to that of a black body at 5776 K. Solar radiation in the visible spectrum region and in the infrared region fit closely with the emission of black body in this temperature. However, the region's ultraviolet (UV) when (wavelength<0.4 μm) of solar radiation deviates greatly from Visible and infrared radiation in terms that equivalent black body temperature of the sun. In the intervening period (0.1- 0.4)μm, equivalent the temperature blackbody of the sun is generally less than5776K with a minimum about 4500K at about (0.16μm) [2] as shown in Figure (1).

Figure 1: Spectrum of Solar Radiation [3]



The maximum spectral density occurs at about (0.48μm) for the wavelength of the color green. The energy spectrum in the ultraviolet region with a (wavelength <0.4μm) is (8.73%). At the same wavelength visible region (0.40μm-0.70μm) is (38.15%). In the infrared region (wavelength>0.7μm) is (53.12%). Solar energy is the energy generated by harnessing the power of the solar radiation and is called photovoltaic system [4]. Photovoltaic energy is the process of converting the sunlight directly to electricity using solar cell [5]. Solar panels can be mounted as a fixed type or used as a tracker type. In the fixed type the solar panel mounted on the surface of roof or ground irrespective of sun's direction at a perpendicular angle [6]. Solar tracker can be divided in two types' passive tracker and active tracker [7]. A solar tracker is an electronic and mechanical device that is used to the maximize absorption of solar power by adjusting the solar panel automatically to be perpendicular to the sun's radiation [8] Figure (2) shows the two types of sun tracker (Single) and (Dual).

Figure 2: (Left) One Axis Tracker, (Right) Dual Axis Tracker [9].



The single axis tracking systems realizes the movement of either azimuth or elevation for a solar power system. The advantages of single axis solar trackers are generally a lower cost than dual-axis trackers, higher reliability than dual-axis trackers and higher lifespan than dual-axis trackers [10, 11]. Dual axis tracking systems realize movement both along the azimuth and elevation axis [12-13-14]. In this paper a single axis tracking system is design and implemented which is detailed in ref. [15]. The aim in this paper study compare output power between fixed panel and tracker panel, effect of different color filters and effect temperature on the output power and efficiency of the single axis solar tracker.

2. Experimental Part

Single axes tracking system is consist solar panel (polycrystalline), photo resistor (LDR), microcontroller (Arduino Uno), relay, DC motor, battery, shaft and gear bearing .The panel used in the designed solar tracking system and fixed system panel made by Kyocera, model is KC85T-1 which is made of (polycrystalline). The specification of the panel at standard test condition has irradiance is 1000 W/m^2 at 25°C, an open circuit voltage is 21.7 V, short circuit current is 5.34 A, maximum power is 87 W, maximum voltage is 17.4 V, maximum current is 5.02 A, fill factor is 0.753, efficiency 14.86%, mass 8.3 kg and area 65×100 cm^2 . After finished the system design and programmed with a suitable commands. The system was tested in the laboratory using artificial Tungsten light source (power 500Watts) as shown in Figure (3) So as to adjust the system's movement from east to west simulate the sun movement.

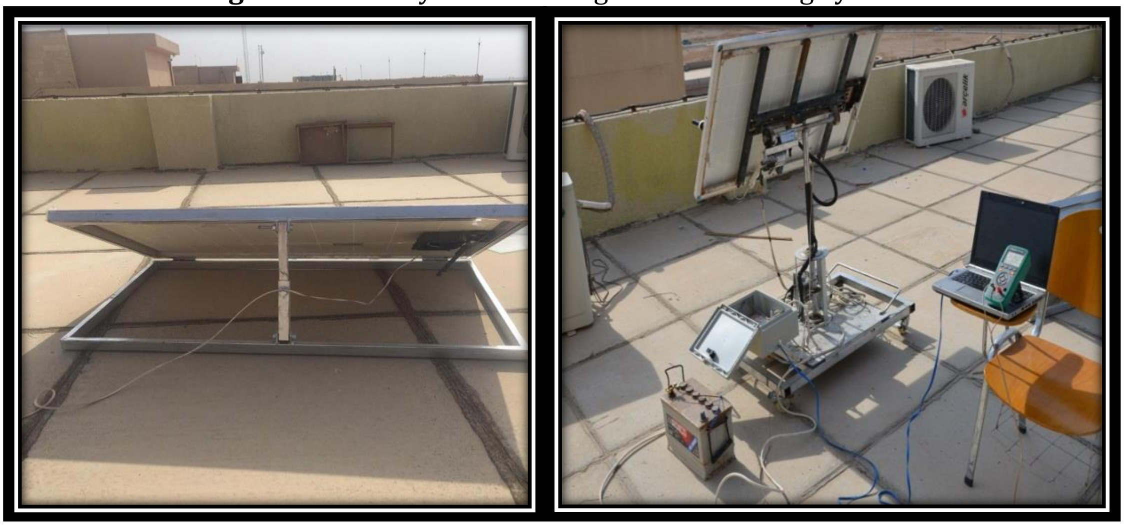
Figure 3: The System Checking in Laboratory

After the completion of testing in the laboratory we tried testing the system in over building college of science, university of Kirkuk (open air) as show Figure (4) .Many difficulty was faced in reducing the threshold value because a large space and receiving global radiation (direct +diffuse) so we put the LDR inside the tube of plastic until the LDRs detects only perpendicular rays of sun.

Figure 4: System Testing in Outdoor.

Two solar panels were used; one of them was fixed at the local latitude 35.47° Kirkuk/Iraq where the other was fitted on the tracking system. The purpose of comparing between fixed panel and tracker panel, the monthly average hourly electrical output power of the two panels were calculated and plotted against the local time during hours of the day (usually 9:00 am-4:00 pm) for April as show figure(5).

Figure 5: Fixed System and Single Axes Tracking System.



3. Results and Discussion

3.1. Output Power Measurement

Figure (6) and figure (7) Shows the comparison monthly average hourly power output (watt) and efficiency (%) characteristic curve from fixed panel and solar tracking system. In April it shows that solar intensity increases with time to maximum at 13 pm and then start decreasing. In fixed panel the variation of the output power increases rapidly with time of day and reaches maximum value at 13 pm o'clock time and then decreases, but in single axes tracking panel the output power increases very rapidly from zero to maximum value and approximately changes very little during the time except in the evening when the irradiance decreases slowly. Solar tracking system is able to receive more sunlight and consequently generate more output power compared to fixed panel because the radiation is perpendicular to the panel. In single axes tracking system has 22% higher output than fixed system.

Figure 6: Monthly Average Hourly Variation of Output Power from Fixed and Tracking Panels in Month of April.

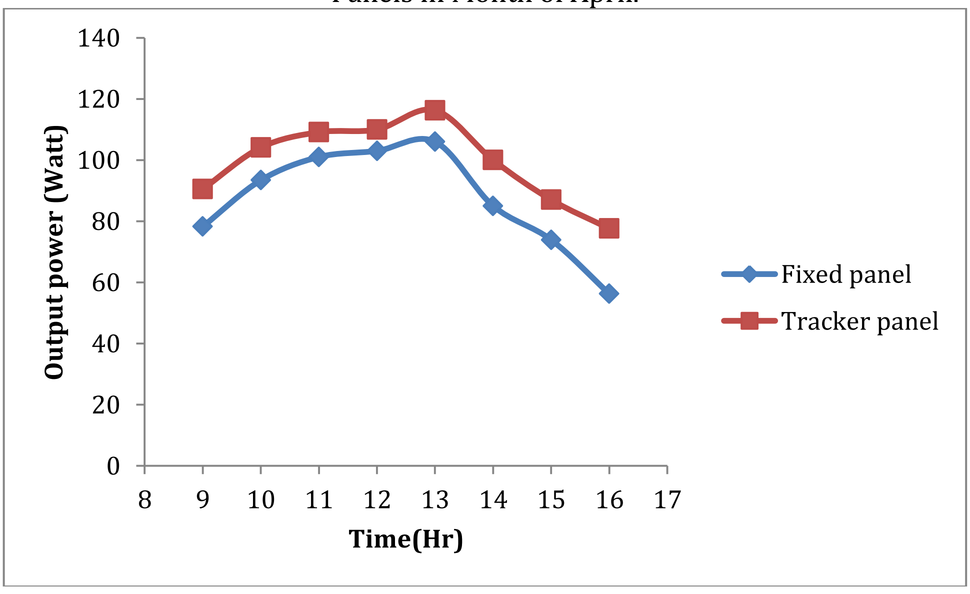
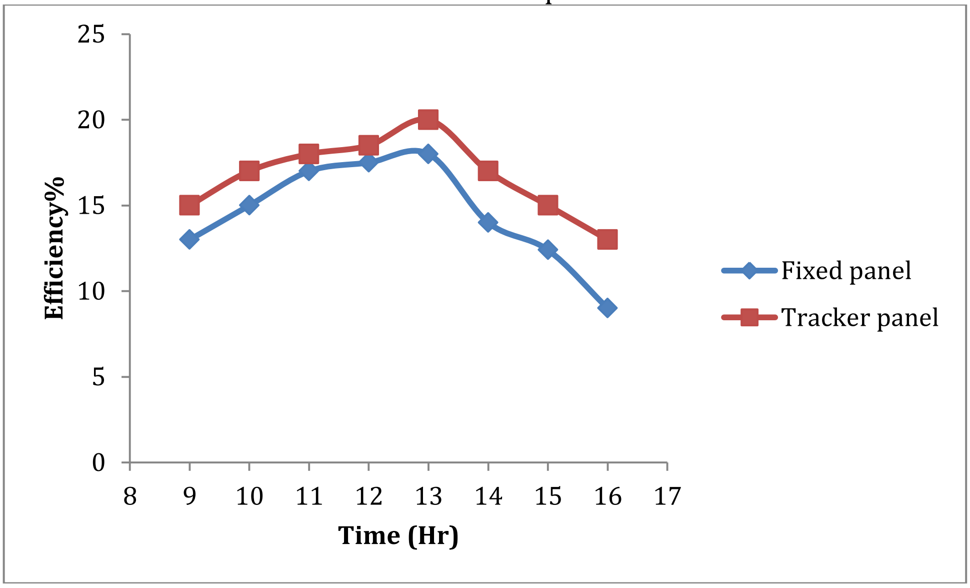


Figure 7: Monthly Average Hourly Variation of Efficiency from Fixed and Tracking Panels in Month of April.



3.2. Effect of the Color Filters on the External Power

Teflon colors sheets were used to absorb all wavelengths of light except that of their own color, thus tinting the light that color. Five color filters of different transmittance were used (Red, Yellow, Orange, Green and Blue) these colors were placed on the same tires dimensions solar panel were measurement output power of each colors on month(August at 12pm). In table (1) the experimental result of output power of the solar PV panel was compared, with and without filter. The current (Ima), voltage (volt) and power (watt) variation of the module with different filters is presented. Due to filters, the module power was significantly reduced in comparison with the module without filters. A greater amount of current was generated when light of a longer wavelength fell upon the photovoltaic cell. This signifies that a relationship between wavelength and current may not be completely linear. The best efficiency obtained was when no filter was used [16-17]. This is due to the reason that module without filter was receiving all the photons of solar radiation compared to the module with filters.

Table 1: Effect the Colors Filters on Output tracking Panel in August.

Color	I(mA)	V(Volt)	Power(Watt)
no filter	5.5	19	104
red	5.4	19	102
orange	5.25	19	99.75
yellow	5.3	19	100.7
green	5.2	18	93.6
blue	5	18	90

3.3. Effect of Temperature on the Output of Panels

Figure (8) and Figure (9) shows plots output power-versus-time (hour) and monthly average hourly panel temperature-versus-time (hour) for the panel tilted 35.47◦ and one axes (east-west) tracking panel for the two months (May and June) measured by thermocouple. It shows the increase in temperature of the solar panel leads to an increase in reverse saturation current leads to a decrease in the open circuit voltage and thus decreases the output power, because the output power of solar cells depends on the temperature. We note that the temperature of solar panel is not equal ambient temperature. This goes in agreement with previous study [18].

Figure 8: Effect of Hourly Average panels Temperature on the Monthly Average Hourly of Output Power for Fixed and Tracking Panels in May.

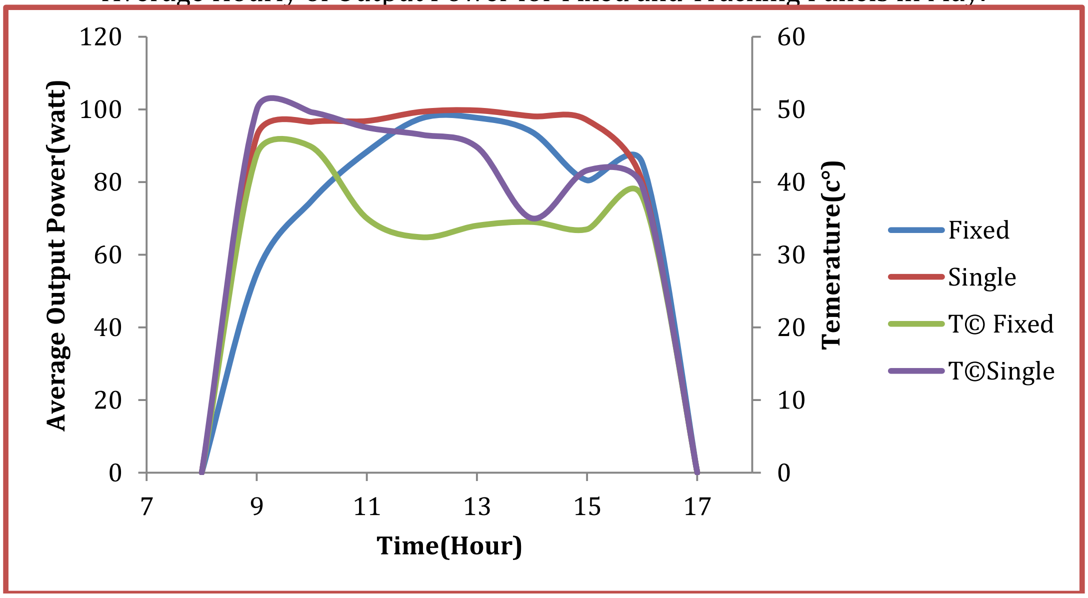
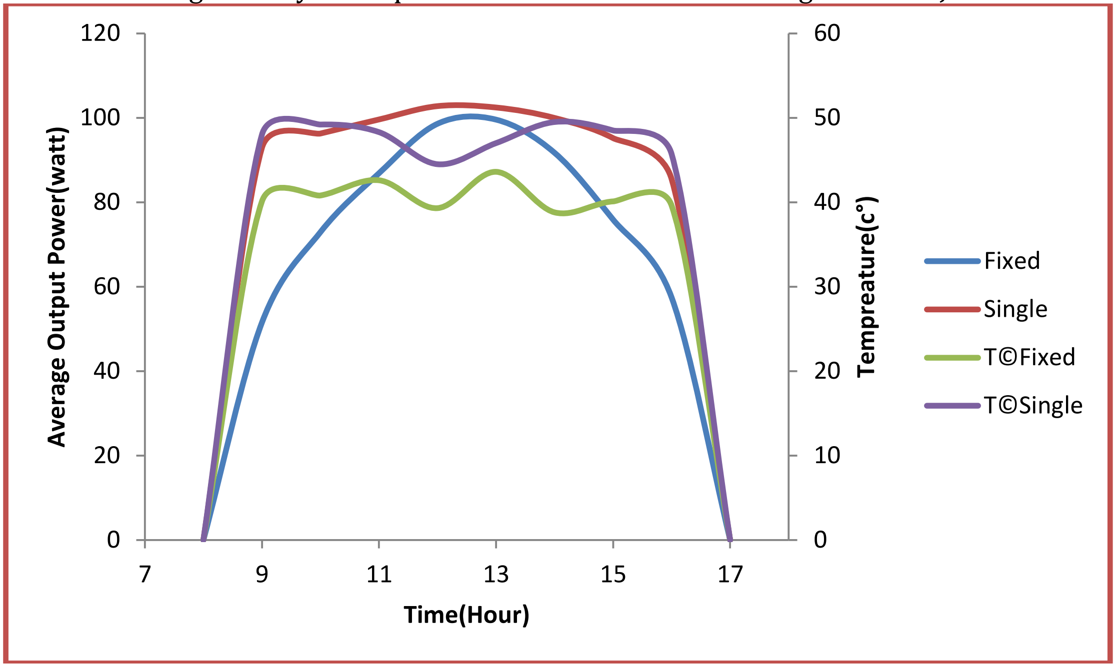


Figure 9: Effect of Hourly Average panels Temperature on the Monthly Average Hourly of Output Power for Fixed and Tracking Panels in June.



4. Conclusions

The main conclusion in our study was:

- Tracker system designed and manufactured with a single axis was practically a cheap cost of materials available in local markets.
- The average external power from one axis tracker system designed in our study was improved by (22%) compared with the fixed panel.
- Higher temperature in summer effect the performance of the photovoltaic panel leads to a decrease in the open circuit voltage and thus decreases the output power, because the output power of solar cells depends on the temperature
- Teflon colors sheets were used to absorb all wavelengths of light except that of their own color, thus tinting the light that color. Experimental result of output power of the solar PV panel was compared, with and without filter. The best output power obtained was when no filter was used.

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