Efficiency of Solar Cells for UAV

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Abstract: ***This study analyzed the C60 solar cell compared to conventional solar cell in terms of efficiency of the solar cell in the application of running brushless motor load. The efficiency of both solar cell output produced will determine if it can support the brushless motor load or not throughout the day, from afternoon at 12pm till the battery drop at 14.8V which is the lowest point of battery can go without damaging it. A detailed analysis has been performed in order to compare the efficiency of both solar cell by measuring both of its output throughout the day from 9am till 3pm by setting up two multimeter to measure current and voltage respectively for both solar cells. A flat cardboard surface is used as platform. Ground Battery endurance test is conducted to get the data of power consumption at different brushless motor load and solar radiance, rate of charge and full battery endurance test with and without solar cell power support from both C60 and conventional solar panel. From the analysis, it was found that C60 solar panel performed better than conventional solar panel on the test conducted. This is due to difference of conversion efficiency between Sunpower C60 and conventional solar panel which were 22.5% and 17.6% respectively. These findings have significant implications for commercial applications when using solar cell. It appears Sunpower C60 solar panel would provide more power than Conventional solar panel during their usage cycle.***

Keywords: ***C60 solar cell, brushless motor load, Sunpower C60 solar panel.***

I. BACKGROUND

When it comes to the performance of solar cells, the performance of a Photovoltaic system depends not only on its basic characteristics but also on the environmental issues. One such environmental issue is the ambient temperature which plays an important role in the photovoltaic conversion process[1]. The solar cell efficiency is usually measured under standard test conditions (STC), with PV cell temperature of 25 C, irradiance of 1000 W/m^2 and air mass ratio AM ¼ 1.5, but these ideal conditions are not possible met at outdoor installations, as the ambient temperature and wind speed affect the performance of the module for that particular locality. The open-circuitvoltage decreases significantly with increasing PV module temperature (values are up to 0.45%/K for crystalline silicon) whereas the short circuit current increases only slightly (values range between 0.04 and 0.09%/K)[2].

I. METHODS

First after acquiring the 30 cells of C60 and 30 cells conventional solar cells because we need enough voltage and current to charge 4 cells Lithium Polymer battery and 16.8V 620KV brushless motor.

Both C60 and conventional solar panel will undergo functional test to check if the solar cells is producing output, if it doesn't another batch of solar cells will be ordered and later undergo functional test, if the solar cell produced output, they are later tested with resistance from 150-watt0.5-ohm potentiometer at various resistance. Several resistancesare used to determine the internal resistance of C60 and conventional solar cell by determine which the resistance the solar cell produce most power (watt). Later, the third test both solar panel with each of its own selected resistance, the solar cell the most power (watt) output from are measured its power (watt), voltage (V) and current (A) at different solar radiation throughout the day and later picked either C60 or conventional solar cell that produce the most overall power (Watt) for the next test.

The fourth test involve a lot of parameter to analyse the data extracted from both solar panel when solar panel is charging the battery and powering the load. The fifth and test involve a couple of parameters to analyse the battery endurance with and without solar power support from both solar panels. The data collected is later analyse and discussed and project summary is written.

II. RESULTS

Test 2 and 3 has been arranged to verify the relationship between changing of solar radiance and the duration of battery to power the 16.8V 620KV brushless motor until the battery drained to 14.8V from its initial full charge of 16.8V with solar support from C60 and conventional solar panel respectively while test 1 is the same as test 2 and 3 but without solar power support. Full test 1, 2 and 3 results of the battery endurance duration with and without solar power support is shown in Table 1.18, 4.19 and 4.20 respectively.

Table 1.1 Test 1 battery full endurance results

Test 1 at 12pm	One 16.8V 620KV Motor speed: 30%		
	1st test	2nd test	3rd test
Voltage of battery after test end (V)	14.8V	14.9V	14.8V
Current, (A)	2.87 - 2.95	2.67 - 2.8	2.90 - 3.0
Wattage, (W)	42.48 - 43.66	39.78 – 41.72	42.92 – 44.4
Duration of battery drained to 14.8V, t(minutes)	35:49	35:13	36:30
Average duration, t(minutes)	35 minute 33 seconds		

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Table 1.2 Test 2 battery full endurance results

Test 2 at 12pm	One 16.8V 620KV Motor speed: 30%		
	1st test	2nd test	3rd test
Voltage of battery after test end (V)	14.8V	14.8V	14.8V
Current, (A)	2.77 - 2.95	2.7 - 2.88	2.93 - 3.0
Wattage, (W)	41.00 – 43.66	39.96 – 42.62	43.36 – 44.4
Duration of battery drained to 14.8V, t(minutes)	4 hours and 30 minutes	4 hours and 23 minutes	4 hours and 27 minutes
Average duration, t(minutes)	4 hours and 26 minutes		

Tables 4.18 and 4.19 of the test shows that C60 solar panel can power the 16.8V 620KV brushless motor at fixed 30% speed while charging the 4S 2600mAh Lithium polymer battery continuously as long there is daylight and from this finding this C60 solar panel is desirable to put onto UAV model for future Endurance flight project.

Table 1.3 Test 3 battery full endurance results

Test 3 at 12pm	One 620KV Motor speed: 30%		
	1st test	2nd test	3rd test
Voltage of battery after test end (V)	14.8V	14.8V	14.8V
Current, (A)	2.77 - 2.95	2.7 - 2.88	2.93 - 3.0
Wattage (W)	34.00 – 36.66	32.96 – 35.62	33.52 – 36.18
Duration of battery drained to 14.8V, t(minutes)	1 hours and 30 minutes	1 hours and 23 minutes	1 hours and 27 minutes
Average duration, t(minutes)	1 hours and 27 minutes		

Tables 4.18 and 4.20 of the test shows that Conventional solar panel can't efficient enough power the 16.8V 620KV brushless motor at fixed 30% speed while charging the 4S 2600mAh Lithium Polymer battery continuously even though there is daylight and from this finding this conventional solar panel is not desirable to put onto UAV model for future Endurance flight project.

Comparing the Battery Endurance

Comparison of battery duration when running with only battery and battery with solar power support.

Extended duration = With solar power battery duration (min) – without solar power battery duration (min)

Table 1.21 Battery endurance duration comparison

Comparison	Duration (minute)
With solar charger using C60 solar panel (minute)	246 minutes
With solar charger using conventional solar panel (minute)	87 minutes
Without solar charger (minute)	35 minutes
The extended duration with solar power support using C60 solar panel (minute)	211 minutes
The extended duration with solar power support using Conventional solar panel (minute)	52 minutes

The Table 1.21 of the test shows that C60 solar panel is very efficient in running one 620Kv brushless motor while charging the battery which extensively prolong the battery endurance while there still sunlight while conventional solar panel aren't efficient enough and con only slightly extend the duration by 52 minutes.

III. CONCLUSIONS

In the first sets of test the C60 and conventional solar panels performed poorly with two 16.8V 620KV brushless motors, the C60 and conventional solar panel can't produce enough power to sustain the demand load that the battery is continuously discharge unlike with one 16.8V 620KV brushless motor where the C60 solar panel can sustain the motor load while charging the battery but conventional performed moderately compared to C60 solar panel to sustain one 16.8V 620KV brushless motor The microcontroller control the motor smoothly and efficiently when it was set by rotating the potentiometer knob at specific position to control at specific speed of 16.8V 620KV brushless motor by means of programming and sent out signal to the electronic controller (ESC) which then control the speed of the 16.8V 620KV brushless motor. The improvement for one 16.8V 620KV brushless motor load is 96.03% while two 16.8V 620KV brushless motor load is around 7.37% while for conventional solar panel however the improvement for one and two 16.8V 620KV brushless motor is around 73.10% and 1.10% respectively.

The second and final sets is to determine the full battery endurance improvement of the battery. Based on the discussion in section 4.3.3, it is found out that the extended duration with solar power support from C60 solar panel is around 211 minutes improvement while for conventional solar panel is around 52 minutes. The C60 solar panels solar charger system is reliable in providing the power support for the main supply battery while powering one 16.8V 620KV brushless motor at 30% motor speed. However, this can be more improved if more solar panels are added to the system to increase the input voltage to carry more load.

Solar cells are recommended to generate power in aviation industry's services and workplaces whenever possible[3-21] as it will generate profit for long-term planning and sustainability besides keeping the environment in check.

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