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Optimization of Electric Cars with Solar Cells and Life-PO4 Batteries

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Abstract: At this time the Makassar Aviation Polytechnic still lacks equipment in energy conversion subjects where one of them is a solar cell-based electric vehicle, this solar cell-based electric vehicle is urgently needed to support learning activities, In this study we made a solar cell-based electric car where this equipment can be used to support energy conversion courses, where in making this equipment the authors need equipment such as electric motors, controllers, solar cell batteries, battery management systems, solar charge controllers, Optimization of electric cars with solar cells is done by converting sunlight captured by the solar cell modules into electrical energy which is then channeled to the charge controller. The voltage on the charge controller is set at 56v 58v which is then forwarded to the battery management system. In this phase the electric current will flow to each battery cell so that the conditions between the battery cells are balanced. the research that has been done has resulted in the conversion of solar energy into electrical energy and the conversion of electrical energy into motion energy. After the manufacturing process is complete, we carry out a testing process where we use the electric car until the car cannot move anymore. The first is the solar cell testing process itself, where the testing process is carried out without a load and with a load and the results show that there is no significant difference to the input voltage or voltage. comes out to the load because the voltage has been regulated by the solar charge controller, and the second is testing the electric car, the first is the position of the solar cell is closed and the second the position of the solar cell is opened, after the experiment is done, the results are obtained which is compared with the time the solar cell is opened with the time the solar cell is open closed there is an efficiency of 13% from the beginning.

Keywords: Solar Cell, Electric Car, Baterai Lifepo4, Optimization

1. Introduction

Makassar Aviation Polytechnic, Airport Technology study program has several practical courses, and to support these practical courses there are several laboratories that are used where one of them is a solar cell-based electric vehicle [1], this solar cell-based electric vehicle is really needed to support cadet learning activities, besides being able to be used for cadet practicums, this electric vehicle can also be used by employees to carry out activities, such as security for roving patrols campus, employees for mobilization between distant that not make pollution [2-4].

In this research we make solar cell car where this equipment can be used to support energy conversion courses and can be used for learning how to convert energy form light energy to electrical energy and then convert form electrical energy to mechanical energy, where in making this equipment the author requires equipment such as electric motors, controllers, solar cell batteries, battery management systems, solar charge controllers, where later we will be able to measure efficiency and output voltage from the utilization of solar cells that will be used and how much efficiency we get from solar energy [5].

2. Method

Research on optimizing electric cars with solar cells and life

PO4 batteries was carried out from April 2022 to September 2022 at the Makassar Aviation Polytechnic Laboratory. This research is a quantitative descriptive research design with 3 stages with the following description.

2.1. Design

The first stage is the design stage of converting a solar-based electric car that will be used for energy conversion practicum, where we will make a solar cell-based electric car using a lifepo4 type battery and how to install it.

The solar cell module captures sunlight then the photovoltaic cell produces electricity which is sent to the solar charge controller.

The electric current goes to the solar charge controller from the photovoltaic cells, the high voltage electricity is around 64v-84 v, the solar charge controller is set to a voltage of 56v 58v then it is channeled to the battery management system.

In the battery management system, when it gets voltage, the battery management system will flow current to each battery cell where each battery will always check and control the voltage by the battery management system so that, then the electricity is regulated to each battery cell so that it is balanced between cells one battery with another battery cell.

After the battery is charged, the battery can supply power to the electric car motor where the flow of power depends on the speed at which the electric car is running [6].

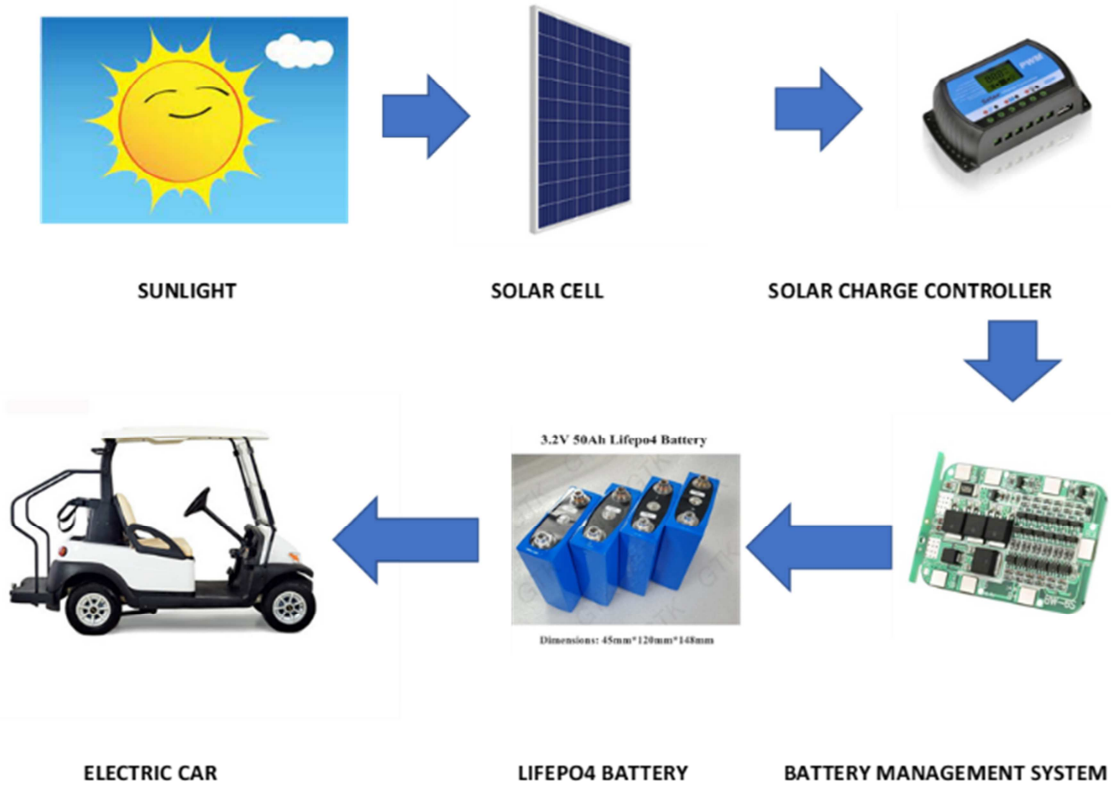

Figure 1. *Solar Cell Electric Car Design.*

2.2. Assembly

The assembly stage is the stage of assembling a solar-based electric car conversion that will be used for energy conversion practicum [7], where are the stages, starting from motor installation, motor controller installation, battery installation, battery management system installation, solar cell installation, solar charge controller installation so that the equipment can function and can be used for practical media.

2.3. Trial

The trial stage is to test the system that has been made whether it is running as it should, where at this stage we will test the battery without load, the battery with load, the mileage before using the solar cell, the mileage after using the solar cell then what is the efficiency can be obtained by adding a solar cell.

3. Results and Discussion

3.1. Results

3.1.1. Hardware Design

Hardware in this study consists of golf carts and motorbikes, 40 wp solar cells, MPPT solar cells, LIfePO4 batteries and Battery Management where later in this study researchers will make a modification intended for electric car where almost the average still uses conventional batteries and because this golf cart is intended for outdoors which will automatically be exposed to continuous sunlight, so the addition of solar cells and devices will help fulfill the electrical energy so that the

use of charging can be minimized due to the energy obtained from the sun.

This car has the concept of a future vehicle because the car itself uses battery power as the driving force for the cart itself. Because it uses electric power, this car has several advantages over other vehicles that use fuel oil.

The type of motor used in this research is a 48 volt DC motor [8], with a power of 3.3 HP with this power is enough to pull the load from the golf cart itself where the maximum power used is 746 watts multiplied by 3.3 which is around 2462 watts.

Figure 2. *DC motor 3.3 HP 48 Volt.*

The solar cell or solar cell used in this study is a polycrystyaline type solar cell, why do we use this type of solar cell, because the polycrystalline type solar cell has its characteristics, although in an overcast position the resulting voltage will be more stable than the monocrystyline type solar cell where we use a 40 wp solar cell as many as 4 pieces installed in series so that the voltage obtained is expected to be more than 48 volts so that it can charge the battery used.

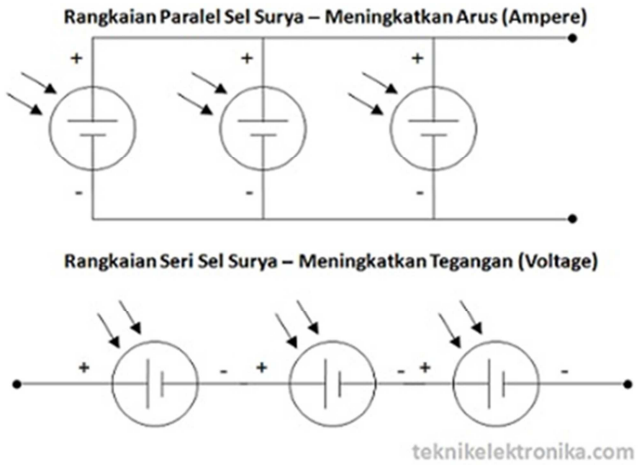

Figure 3. *Solar Cell Series and Paraller Circuits.*

The solar charge controller is a battery charger that is supplied from a solar/photovoltaic panel. This electronic kit serves to regulate the current from the solar panels to the battery [9]. The charge controller functions to control the charging of the accumulator battery charge so that the charging process occurs in conditions that are safe for the accumulator battery.

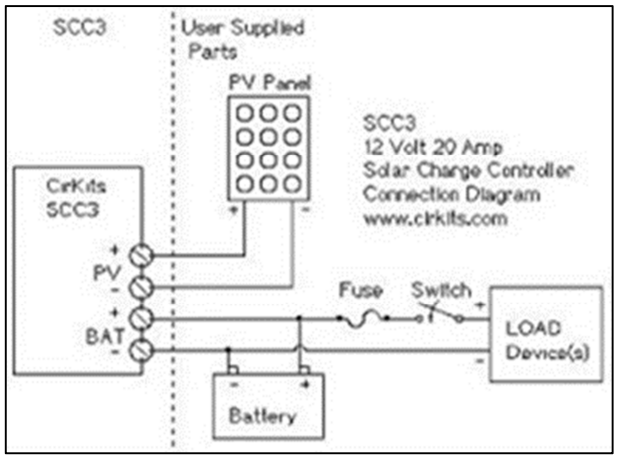

Figure 4. *Simple solar system.*

The solar charge controller used in this study can supply automatically depending on the input power entered, for example, only 1 solar cell is inserted, the output voltage is 12 volts, if 2 units, the output power is 24 volts, what we use is 48 volts and the maximum current that can be supplied is 100 amperes which is enough for a dc motor with a power of 3.3 HP 48 volts [10].

The battery management system that we use is a battery management system that has a power of 100 amperes, a configuration of 15 series and a nominal voltage of 48 volts [11], so that it can meet the requirements used where the motor power used is 2462 watts where the maximum power used is 50% of the maximum amount that can be released by the battery management system, so the risk of the equipment getting hot will be very small.

3.1.2. Assembly

Replacing 6 conventional self-regulated conventional batteries with a voltage of 8 volts and a power of 50 ah with a series of 15 lithium ferro phosphate batteries so that you get a nominal voltage of 48 volts and with twice the power from the start [12].

Installation of solar cells with the help of iron supports on the golf cart roof [13] with a series configuration of 4 pieces so that a voltage of 48 volts is obtained with help of solar charger controller [14].

Installing the charge controller in the tub of an electric car using acrylic as a cover to prevent rainwater from entering and Installing a battery management system for each battery cell so that it can monitor and charge evenly between one battery and another.

3.1.3. Trial

No-Load Solar Cell Test Results

To find out the results of this tool, testing and analysis of the tool will be carried out. The first test and data collection is carried out on solar panels where we do solar panel testing without using batteries where solar panels are dried in the sun all day to find out how much voltage is released from morning to evening.

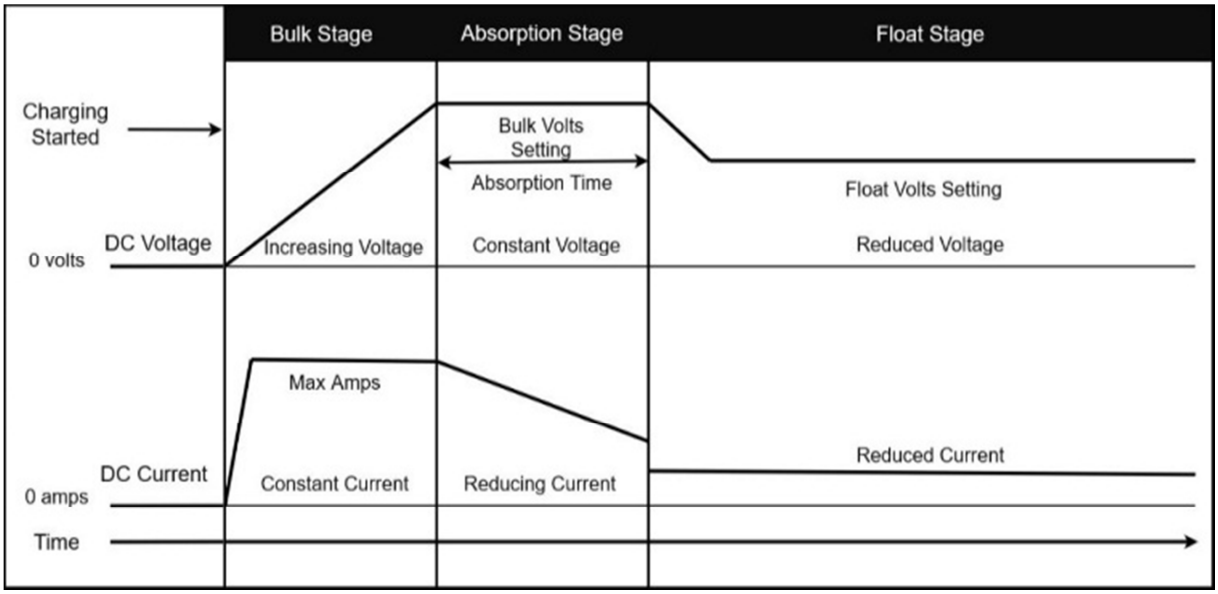

Figure 5. *Solar Cell characteristic.*

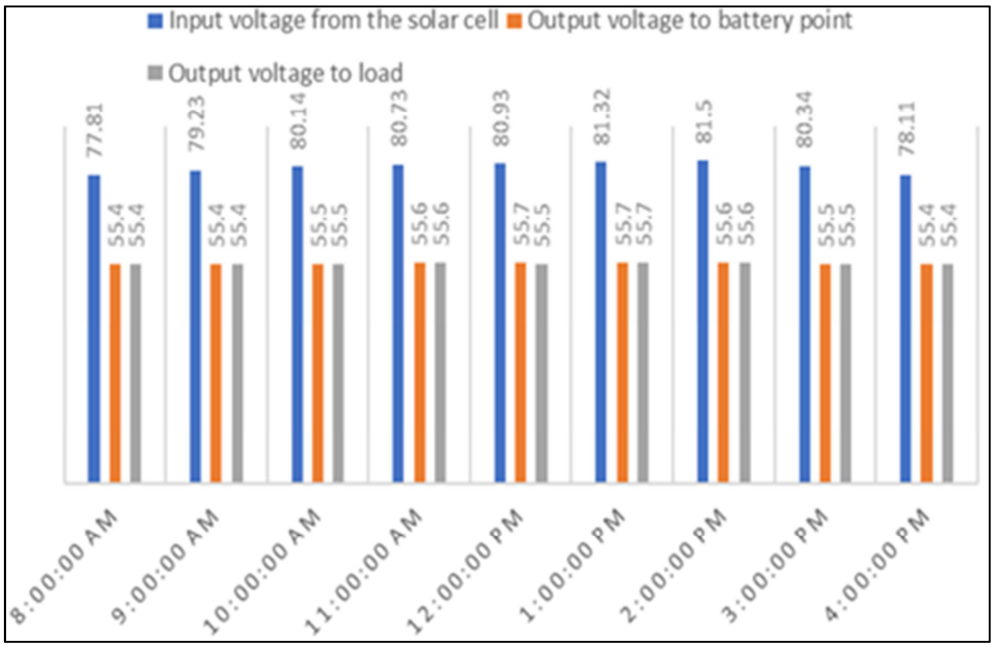

Figure 6. *Testing of Solar Panels and Solar Charge Controllers without load.*

Solar Cell Test Results with a Load

The second test and data collection is carried out on solar panels where we do solar panel testing using batteries attached, where solar panels are dried in the sun all day to find out how much voltage is released from morning to evening.

Voltage and Mileage Test Results with the Solar Cell Closed

In this test the electric car was tested without a solar cell which only relied on a fully charged battery and was run at an average speed of 20 km/hour until the battery power ran out.

Figure 7 Voltage and Mileage Test Results with the Solar Cell Closed.

Voltage and Mileage Test Results with the Solar Cell Opened

In this test, the electric car was tested with the addition of a solar cell where the solar cell and fully charged battery were paralleled and run at an average speed of 20 km/hour until the power in the battery runs out.

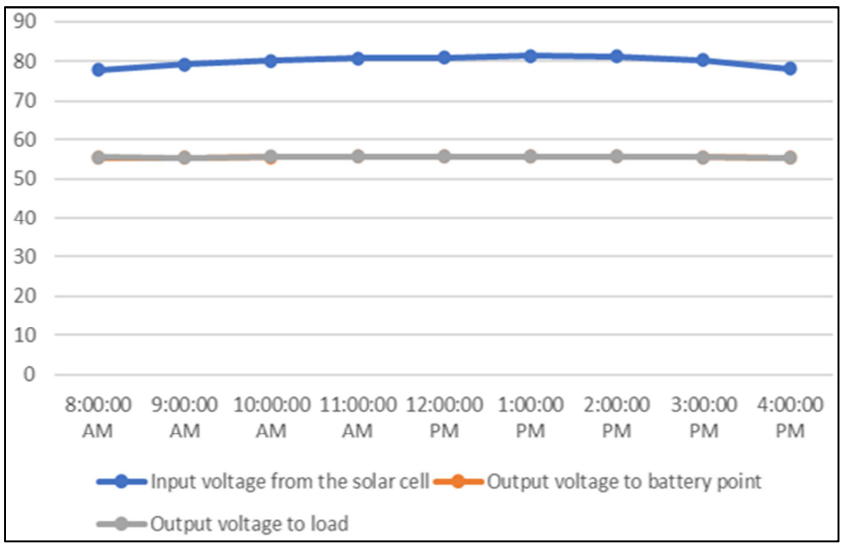

Figure 7. *Testing of Solar Panels and Solar Charge Controllers with load.*

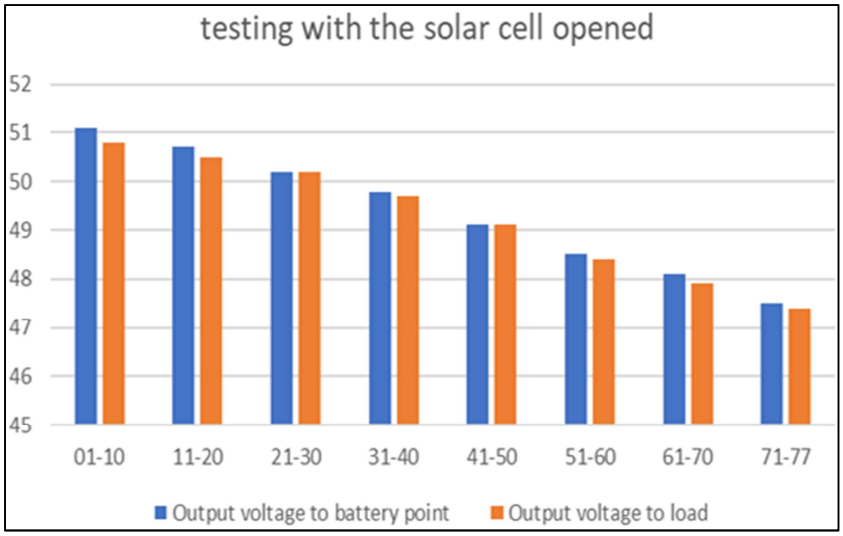

Figure 8. *Voltage and Mileage Test Results with the Solar Cell open.*

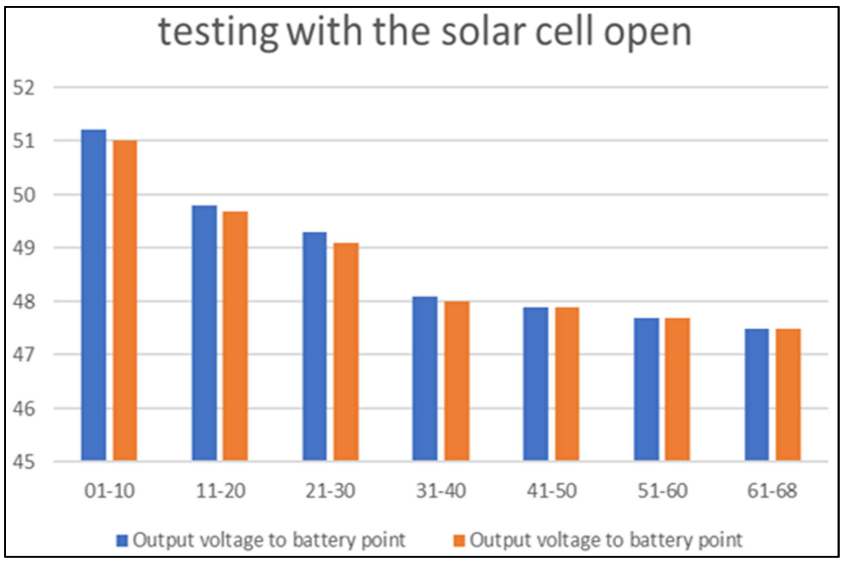

Figure 9. *Voltage and Mileage Test Results with the Solar Cell open.*

3.2. Discussion

After conducting research it was found that from the beginning of the test it was found that with the use of a polycrystalline type solar cell the output voltage had a deviation although only slightly where the range was between 77 volts to 82 volts [15] while the output of the solar charge controller obtained constant results where the output voltage was shown at 55 volts.

for efficiency at the time of testing with the closed position of the solar cell compared to the open condition solar cell, an efficiency of almost 13% was obtained [16] where in the first test the electric car was able to drive as far as 69 km and after adding the solar cell the electric car was able to go as far as 78 km [17, 18].

4. Conclusion

This research and development produces a product in the form of learning media in terms of energy conversion practicum which in this case is the conversion of solar energy into electrical energy as well as the conversion of electrical energy into motion energy.

After changing the energy storage system and adding solar cells to electric vehicles, their use becomes more efficient, initially being able to rotate around 69 km, after opening the solar cells can rotate up to 78 km.

In this case there is an efficiency of almost 13%, and under normal circumstances charging takes longer, because in silence and in cloudy conditions charging will automatically occur via a solar cell.

Polycrystalline type solar cell the output voltage had a deviation although only slightly where the range was between 77 volts to 82 volts while the output of the solar charge controller obtained constant results where the output voltage was shown at 55 volts.

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