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COMPARISON OF LITHIUM ION AND LITHIUM POLYMER PERFORMANCE AS SOLAR PANEL ENERGY STORAGE

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ABSTRACT

Batteries have an important role in the development of energy needs. Good battery performance will support the devices it supports. The energy that can be stored in a battery is limited, so the battery will experience a cycle of charging and discharging. Improper charge and discharge processes can cause battery performance to decrease. Therefore, it is necessary to monitor battery performance in order to determine maximum battery performance. One of the aspects needed to monitor the state of charge and Depth of Discharge is to monitor the voltage, current and temperature on the types of lithium ion and lithium polymer batteries as energy storage for solar panels by using Arduino Atmega as a controller to determine the percentage of lithium ion and lithium polymer batteries and displayed on the LCD as HMI. From the results of comparing the performance of lithium ion and lithium polymer batteries, the results of SoC and DoD are measured and displayed on the LCD accurately, it can be seen which one is faster in charging time and lasts longer in use so that performance can be known of the two types of batteries.

Keywords: *SoC, DoD, Lithium Ion, Lithium Polymer*

PRELIMINARY

Batteries have now become part of everyday life, for modern life today batteries have become a necessity that is inherent in every activity, especially those related to electronic devices. The development of batteries that are increasingly advancing towards a better direction, continues to be carried out by experts. Especially now that the world community is trying to find alternative energy in the form of non-oil and gas. Utilization of batteries used as alternative energy storage media which is first converted into electrical energy. One of the efforts to save from dependence on petroleum [1].

In the utilization of solar energy into electrical energy, solar panels are needed as a converter of solar thermal energy into electrical energy, and the electrical energy is stored in the battery to be distributed to the load. At this time the type of battery is getting more and more powerful to store electrical energy, one of which is lithium ion and lithium polymer batteries where in one battery there are several cells to store energy, which can increase its storage capacity and can issue a greater voltage. So here it is necessary to monitor the performance of the charger to determine the State of Charge (SoC) and Depth of Discharge (DoD)[2].

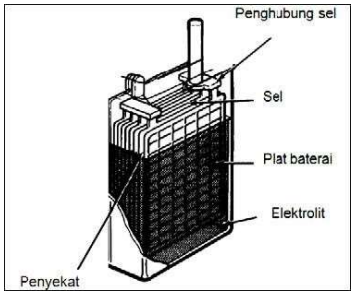
State of Charge (SoC) is defined as the percentage of available battery with maximum battery capacity. The SoC value is stated in the range 0-1 or 0%-100% with 1 or 100% indicating the battery is empty. SoC is classified as an important parameter of battery capacity, which can only be estimated indirectly through the collected voltage data. This research will design a comparison of charging and discharging performance with 2 different types of batteries, by monitoring voltage, current and temperature sensors for knowing the SoC and DoD controlled from Arduino Atmega.

THEORETICAL BASIS

A. Battery

A battery is a device that can convert energy. An electric battery is a device consisting of 2 or more electrochemical cells that convert stored chemical energy into electrical energy. Each cell has a positive pole (cathode) and a negative pole (anode). The pole with a positive sign indicates that it has a higher potential energy than the pole with a negative sign. The negative marked pole is a source of electrons which when connected to an external circuit

will flow and provide energy to external equipment. When the battery is connected to an external circuit, the electrolyte can move as ions in it, resulting in a chemical reaction at both poles. The transfer of ions in the battery will drain the electric current out of the battery so as to produce work. Although the technical term for a battery is a device with



multiple cells, a single cell is also commonly referred to as a battery.

Figure 1. Cell Battery

B. State of Charge (SoC)

SOC is defined as the ratio of the total usable energy capacity of a battery to the total battery capacity. The SOC describes the available energy and is expressed as a percentage according to some references, sometimes taken as the rated capacity of the battery. How to estimate SOC based on voltage, by measuring battery cell voltage as a basis for calculating SOC or remaining capacity. The result may change depending on the actual voltage level, temperature, discharge value.

C. Depth of Discharge (DoD)

Depth of Discharge (DoD) is a provision that limits the maximum discharge depth that can be applied to the battery. The DoD setting plays a role in maintaining the life time of the battery. The deeper the DoD applied to a battery, the shorter the lifetime of the battery. The following is a table that shows the relationship between DoD and the life of a battery.

DESIGN

A. Block Diagram

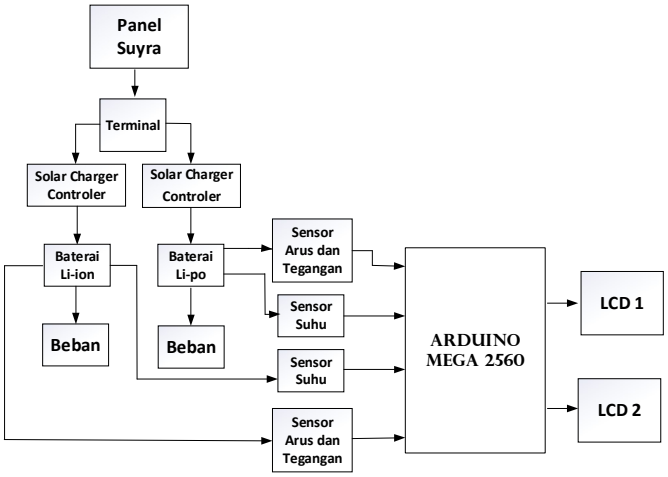


Figure. Block Diagram

The hardware design of the lithium Ion andlithium polymer battery comparison systemas a solar panel energy storage consists of input, control, display. From these partsthere are hardware and software. The input section consists of a dc voltage sensor, a dccurrent sensor, and a temperature sensor tosee the voltage and current values for charging the battery. On the output side there are sensors for voltage, dc current, andtemperature for calculating the percentage of battery which will be displayed on the LCD as HMI. The software used toprogram the microcontroller is Arduino IDE. This software is used to monitor the SoC and DoD of both batteries. The

monitoring system on the battery is carriedout with the aim of knowing theperformance of the two batteries by lookingat the resulting SoC and DoD values. The scheme of sending data from the sensor to the HMI will be processed by Arduino as microcontroller which is then displayed on an LCD.

B. FLOWCHART

A. Main Flowchart

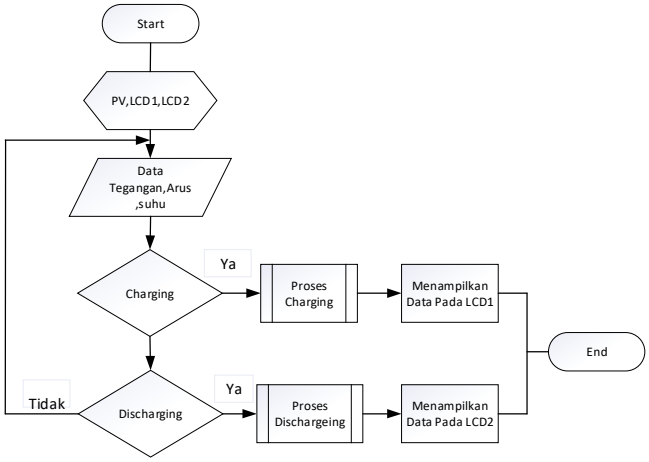


Figure 3. Flowchart of Monitoring the Performance of Lithium Ion and Lithium Polymer Batteries as Energy Storage for Solar Panels

This tool works to determine the SoC and DoD on both batteries which are measuredusing a DC voltage sensor, DC current andtemperature. For the charging parts of the battery, there is the same charger control and the same voltage and current values, inorder to find out how efficient the two typesof batteries are, and to determine the efficiency of the two batteries so that they can be displayed on the LCD as an HMI.

B. Charging Process

From the charging process, it can be seen the value of the voltage and current through the DC current sensor and DC voltage sensor and if the battery voltage is less than 7.4 volts it will return to the sensor reading to continue charging and if the battery is more than 7.4 volts it will get SoC value is 100% so it can be said that the battery is full.

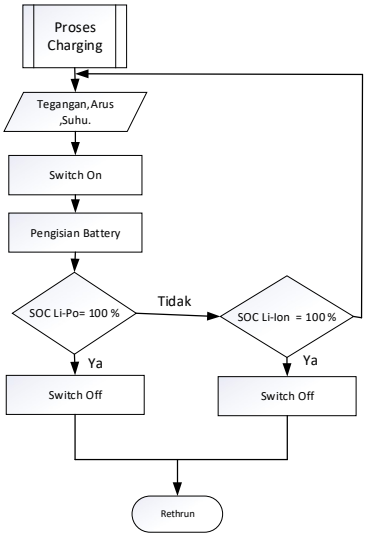


Figure 4. Charging Flowchart

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C. Discharging Process

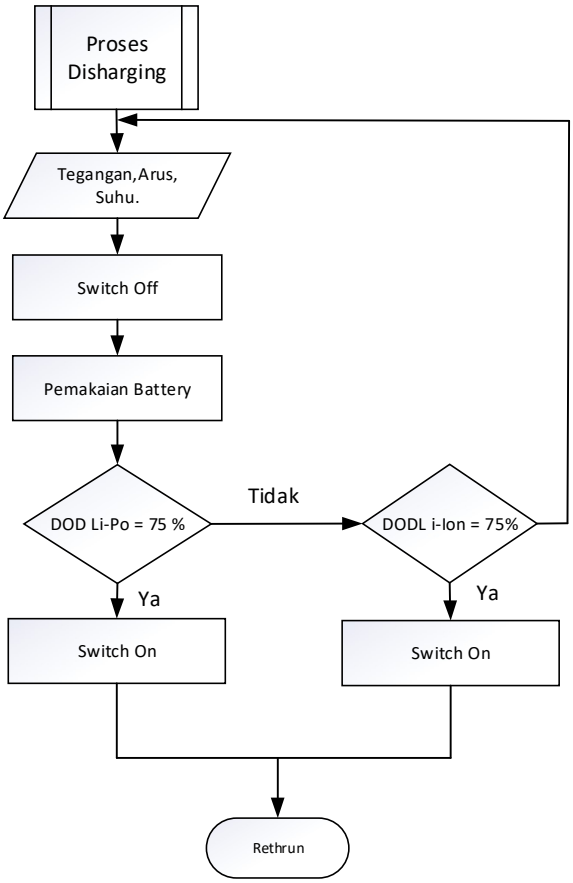

Figure 5. Flowchart of Discharging

From the discharging process it can be seenthe value of the voltage and current, to turnon the load and if the battery voltage is lessthan 6 volts it will charge automatically which is decontrol through the charger control.

ANALYSIS AND DISCUSSION

A. Solar Panel Graphics

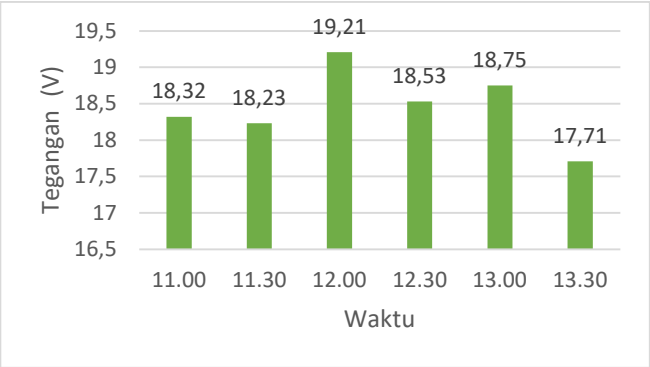

Figure 6. Solar Panel Voltage

From Figure 6, shows that the maximum voltage is obtained at 12.00 with bright conditions.

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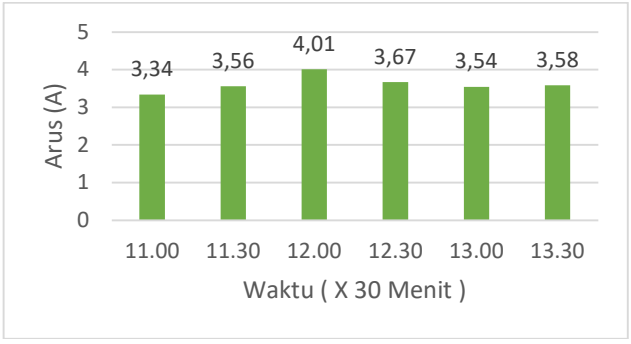

Figure 7. Solar Panel Current

From Figure 7, the largest current is produced at 12.00 with a current value of 4.01 A.

B. Charging Process

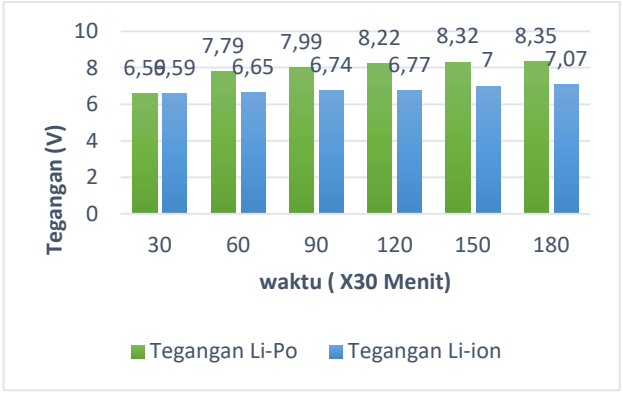

Figure 8. Voltage when Charging

Figure 8 is the result of implementing a device with a charging process that takes place successively including battery voltage and time.
On the voltage curve when charging for 180 minutes it can be seen that the voltage on the voltage graph rises steadily. If you refer to the battery datasheet, it can be seen that the two batteries experience a voltage difference when charging, namely the li-po battery has increased faster than the li-ion.
Figure 9 is the result of implementing the device with a charging process that takes place successively including battery current and time.

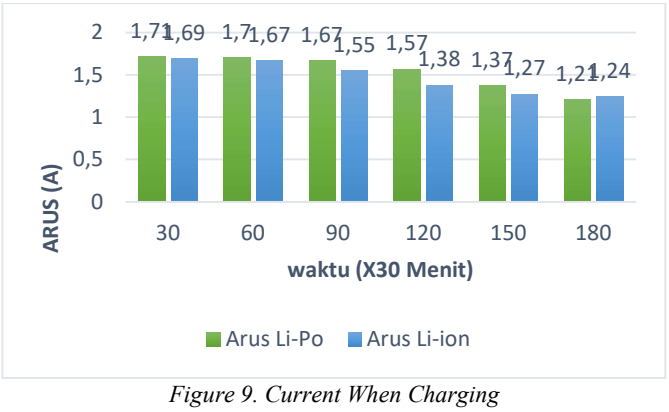

Figure 9. Current When Charging

On the current curve when charging, it can be seen that the current on the current graph drops constant. If you refer to the battery datasheet, it appears that the current has a range that tends to be linear. The difference in the graph can be due to the charging process caused by the charger control which makes the current different.

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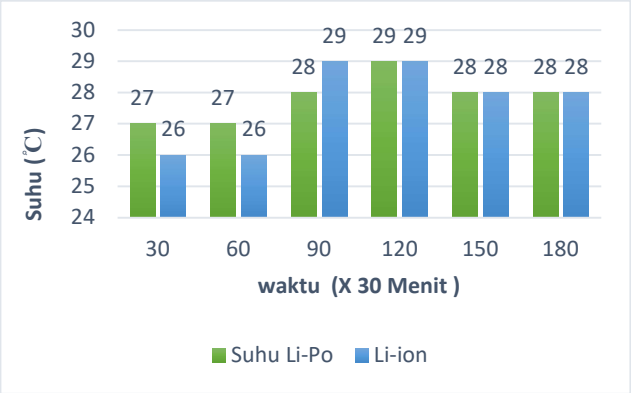

Figure 10. Temperature when Charging

Figure 10 is the result of the implementation of the device with a charging process that takes place successively including battery temperature and time.
On the temperature graph when charging, it can be seen that the Li-Po and Li-ion batteries experience a temperature difference that is not too far away in 180 minutes, and the battery experiences a different temperature rise.

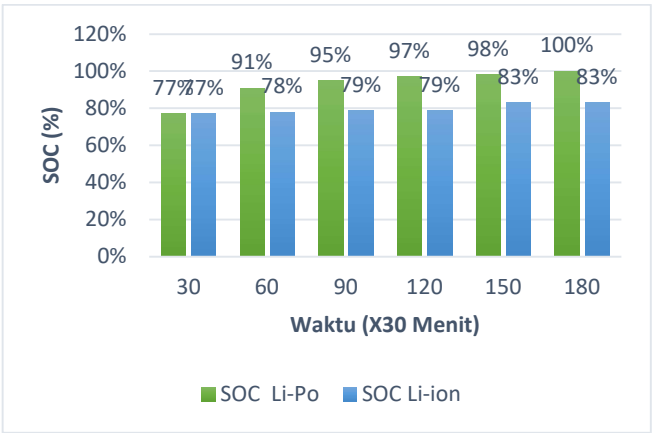

Figure 11. Charging Process

The filling process is slightly different at the time of discharge. The charging process uses a power supply that serves as a source to charge the battery. Here's a graph of battery charging. In graph, there is a charging process for 180 miutes with a minimum SoC of 77% and a maximum of 100%. From graph, it can be seen that the increase in voltage from 77% increased significantly towards a value of 100%. For li-po battery and for li-ion battery, there was an increase but from 77% it rose to 83%.

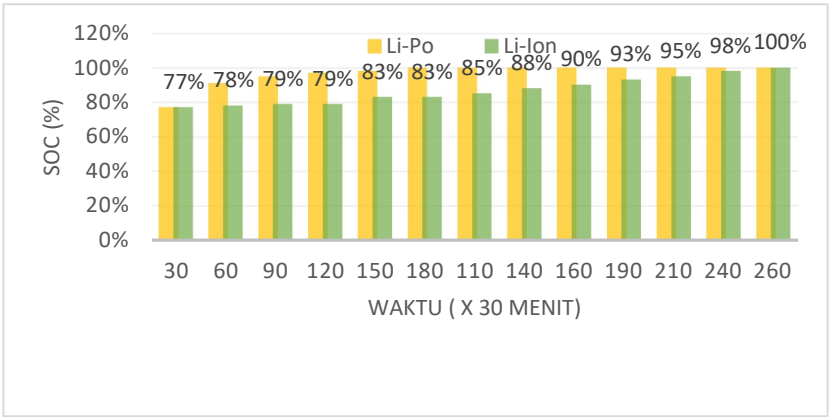

Figure 12. Charging Process

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The experiments conducted by the author is used to find out how long the charging time of the two types of batteries.
Figure 12 shows that the lithium polymer battery charging time is faster than lithium ion with a time of 180 minutes for lipo and 260 minutes for li-ion with the same initial percentage of 77%, so it can be concluded that the Li-po battery charging process is faster.

C. Discharging Proses

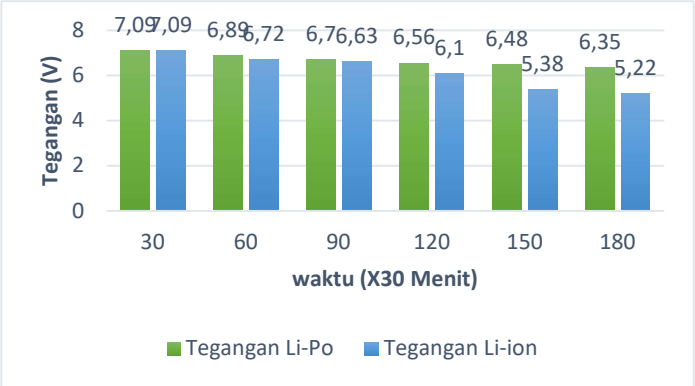

Figure 13. Voltage when Discharging

The results of the implementation of the tool with a continuous discharging process including battery voltage and time. When the battery is discharging, it can be seen on the graph that the voltage drops steadily. If you refer to the battery datasheet, it appears that the voltage has a range that tends to be linear. The difference in the graph can be due to the imperfect discharging process and the condition of the battery starting to decrease in capacity.
Figure 14 is the result of implementing a device with a continuous discharging process including battery current and time.

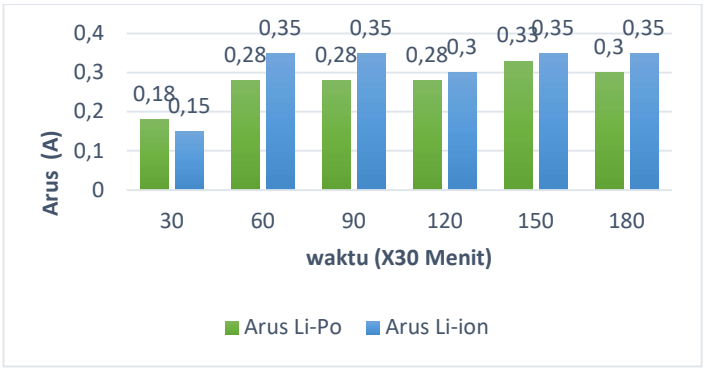

Figure 14. Current when Discharging

When the battery is discharging, it can be seen on the graph that the current is irregular as the demand from the load requires a suitable current. From the two types of batteries, the current issued is not the same even though the load used is the same, namely the PG45 motor with a period of 180 minutes.

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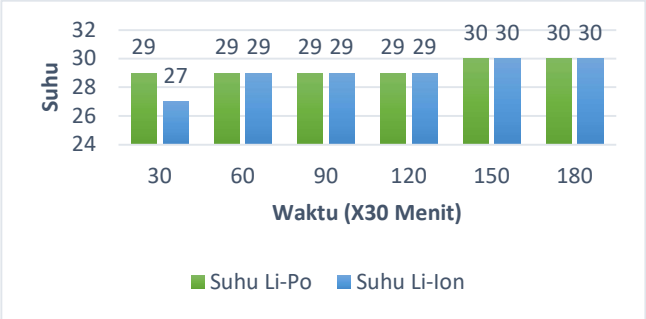

Figure 15. Temperature when Discharging

Figure 15 is the result of implementing a device with a discharging process that lasts for 180 minutes with measurements including battery temperature and time. C temperature increases as battery power decreases.

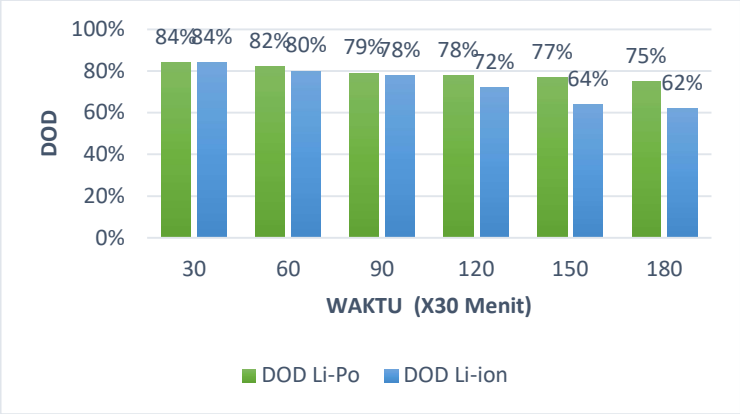

Figure 16. Discharging Process

From Figure 16, between li-po and li-ion batteries showing a very significant difference from 180 minutes. From the difference, it shows a graph of the decline of the two batteries. The one that experienced a faster decline was li-ion. With this graph, it can be said that Li-Po batteries last longer than Li-Ion.

CONCLUSION

From the tests conducted by the author, the following conclusions can be seen:

1.From the experiment above, it shows that the charging time of Li-Po and Li-ion with a time of 3 hours and a battery percentage value of 77% results in a Li-Po battery being fully charged faster than a Li-ion battery, with a time difference of 60 minutes.

2. From the experiment above, it shows that the discharging time of the two types of batteries has a different lifetime of 180 minutes of use. The results show the initial percentage of 84% decreased to 75% by using a PG45 motor load for a li-po battery, and for a li-ion battery from 84% down to 62% with a PG45 motor load. So it can be concluded that the use of the li-ion battery is more durable than the Li-Po type of battery.

3. For the temperature of these two types of batteries at the time of charging and discharging also experience differences. From the beginning of the charging process the temperature shows a normal temperature and at the time of charging it increases and decreases when the battery is full.

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