COMPARISON ON STUDY OF LITHIUM ION PARALLEL & LEAD ACID PARALLEL CHARGING & DISCHARGING CHARACTERISTICS

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ABSTRACT:-

Lead acid battery may be used in parallel with one or more batteries of equal voltage. When connecting batteries in parallel, the current from the charger will tend to divide almost equally between the batteries. No special matching of batteries required .If the batteries of unequal capacity are connected parallel, the current will tend to divide between the batteries in the ratio of capacities (actually, internal resistances).When charging batteries in parallel, where different ratios of charge are to be expected, it is best to make provisions to assure the currents will not vary too much between batteries. Lithium batteries can be connected to generate more energy to run larger motors or extra capacity. Connecting the lithium batteries in parallel is one way to increase the ampere-hours of a battery. As far as disadvantages, placing batteries in parallel can make them take longer to charge. Also, the lower voltage means higher current draw and more voltage drop. It may be difficult to power large applications, and one need thicker cables. Imbalanced lithium-ion cells die the first time one try to use them. This is why balancing is absolutely required. Battery cells, especially lithium cells are very sensitive to overcharging and over-discharging. Balancing is only necessary for packs that contain more than one cell in series. Parallel cells will naturally balance since they are directly connected to each other, but groups of parallel wired cells, wired in series (parallel-series wiring) must be balanced between cell groups.

1.INTRODUCTION:-

When connecting lithium batteries in parallel, it is best to charge each battery individually before making the parallel connections.

Lead acid batteries may be used in parallel with one or more batteries of equal voltage .When connecting batteries in parallel , the current from a charger will tend to divide almost equally between the batteries . Batteries that are only in parallel keep the same voltage and increase their capacity. Charging properly a lithium-ion battery requires 2 steps: Constant Current (CC) followed by Constant Voltage (CV) charging. A CC charge is first applied to bring the voltage up to the end-of-charge voltage level. The choice of how to charge depends on the current restrictions of your charger and power supply.Connecting in parallel requires you to connect the negative terminal of one battery to the negative terminal of the next, as well as connecting the positives to the positives. Using each battery terminal lead ensures that the voltage stays the same, but the overall capacity increases. Lithium-ion battery with a smart battery management system never overcharge the battery and it avoid deep cycling and extreme temperature. To keep lithium-ion battery healthy one must use partial-discharge cycles and should avoid charging to 100% capacity. One must select the correct charge termination method & Limit the battery temperature. One should avoid high charge and discharge currents and avoid very deep discharges. When battery is discharging, it is recommended that one only let it reach 50 percent before topping it up again. While charging it back up, one should also avoid pushing a lithium-ion battery all the way to 100 percent. As far as disadvantages, placing batteries in parallel can make them take longer to charge. Also, the lower voltage means higher current draw and more voltage drop. It may be difficult to power large applications, and you'll need thicker cables. Imbalanced lithium-ion cells die the first time you try to use them. This is why balancing is absolutely required. Battery cells, especially lithium cells are very sensitive to overcharging and over-discharging.

1.2 MATLAB:

Matlab is a high-level language with interactive environment which enables to performing computationally intensive tasks faster than with traditional programming languages such as C , C++ and FORTRAIN. It has various components to support simulation of various complex electrical and power electronics systems.

Simulink: Simulink is a platform for multidomain simulation and Model-Based Design for dynamic systems . It provides an interactive graphical environment and a customizable set of block libraries and can be extended for specialized applications. Simulink library Information inserts a table that lists library links in the current model, system, or block.

Simscape:

Simulink is a graphical programming environment for modelling, simulating and analysis of dynamic systems where as Simscape is a Physical modelling part in simulink environment. It extends Simulink with tools for modelling and simulating basic electrical circuits and detailed electrical power systems. These tools facilitate modelling of the generation, Transmission, distribution, and consumption of electrical power, as well as its conversion into mechanical power. Sim Power System is well suited for the development of complex, self-contained power systems and power utility applications.

1.3 Battery Performance Parameters:-

The Performance Parameters of Battery are SOC(State of Charge),Depth of Discharge and Charging and Discharging rates .

1.3.1 SOC: - It gives the ratio of the amount of energy presently stored in the battery to the

Nominal rated capacity. It is the fraction of the battery capacity that has been used over the total available from the battery.

1.3.2 Depth of Discharge: **-** The Depth of Discharge of a battery determines the fraction of power that can be withdrawn from the battery.

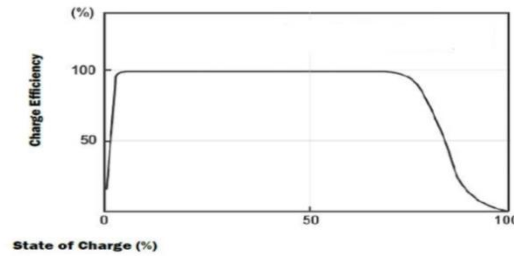

Figure 1.1 :- Graph between State of charge and charge Efficiency

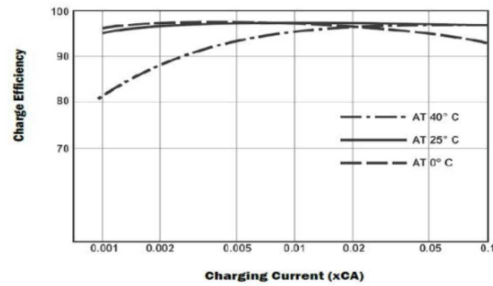

Figure 1.2:- Graph between Charging current & ChargeEfficiency

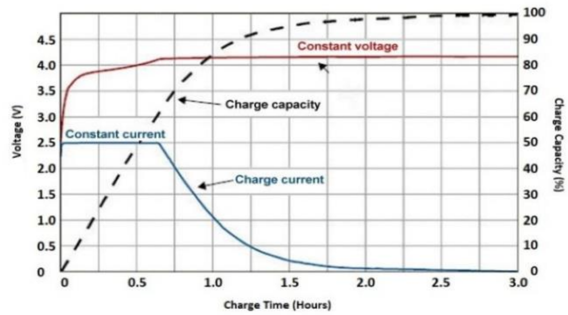

Figure 1.3:- Charge curve of Lithium –Ion Battery

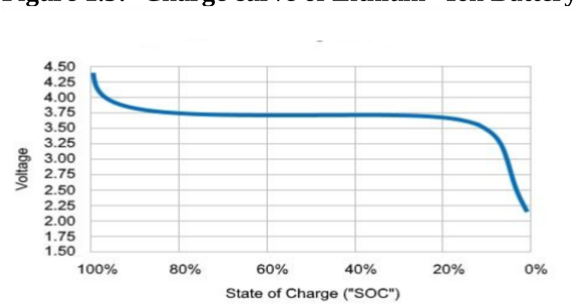

Figure 1.4:- Discharge curve of Lithium–Ion Battery

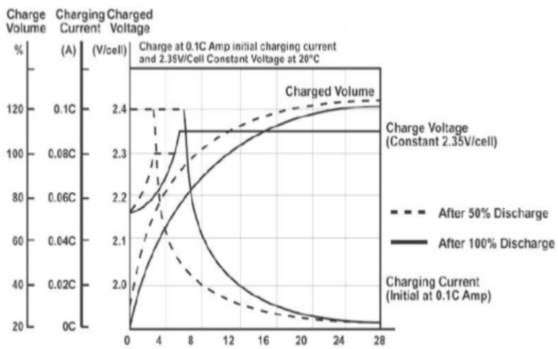

Figure 1.5:-Lead Acid battery charge characteristics taking case that charging is non continuous and peak voltage higher.

2. PROBLEM STATEMENT-

To observe the SOC and charging current of Lithium ion parallel and Lead acid parallel batteries with different loads using Matlab Simulink and Simscape.

OBJECTIVE–

1. Identifying time duration while charging different batteries separately and in different combination.
2. Identifying variation in charging current characteristics of different batteries.
3. Design and develop the circuit for display of SOC and charging current for different varying loads through simulation.
4. Experimentation and validation of results.
5. Analysis of results.

3. LITHIUM ION-LITHIUM ION PARALLEL CHARGING:

Prallel combination of Lithium Ion-Lithium-Ion & Lead acid-Lead acid battery charging is shown in figure and design parameters are also shown below .Simulation results are shown both in display and waveform basis .

DETAIL SPECIFICATION OF BATTERIES FOR PARALLEL CHARGING:-

DCvoltage source=15 volt

Nominal voltage of both batteries=7.2 volt

Rated capacity=55Ah

Initial state of charge=55%

Battery response time=30 second

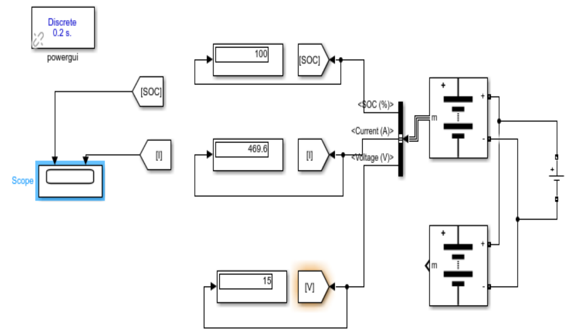

Figure 3.1:-CIRCUIT DIAGRAM OF BOTH BATTERY CONNECTED IN PARALLEL FOR 1 HOUR

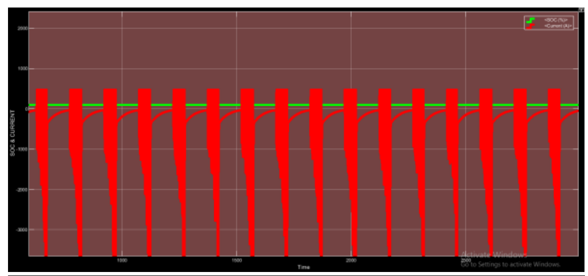

Figure3.2:-SOC & CURRENT WAVEFORM OF BOTH LITHIUM ION BATTERY CONNECTED IN PARALLEL FOR 1 HOUR

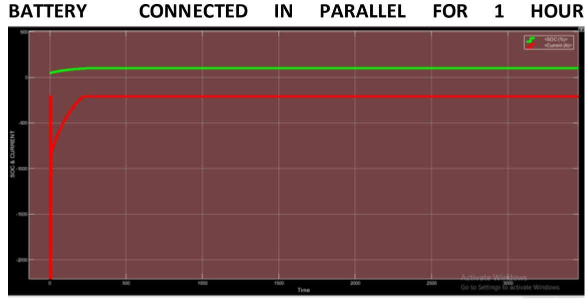

Figure3.3:- SOC & CURRENT WAVEFORMM OF BOTH LEAD ACID BATTERY PARALLEL CHARGING FOR ONE HOUR

ANALYSIS OF PARALLEL BATTERY CHARGING

ANALYSIS OF LITHIUM ION –LITHIUM ION PARALLEL BATTERY CHARGING: - Initially the SOC & nominal voltage of both lead acid & lead acid battery taken as 45% and 7.2 volt. The SOC reaches to 100% and charging current becomes 469.6 mille Ampere within a period of 1 hour as observed i.e with 15 volt DC source for charging lead acid battery of initial voltage of 7.2 volt, the charging current initially very low & then reduces and this reduced current maintains constant throughout .

ANALYSIS OF LEAD ACID –LEAD ACID PARALLEL BATTERY CHARGING: - Initially the SOC & nominal voltage of both lead acid & lead acid battery taken as 45% and 7.2 volt. The SOC reaches to 100% and charging current becomes -207.8 mille Ampere within a period of 1 hour as observed. The charging current was more initially and reduced to constant i.e with 15 volt DC source for charging lead acid battery of initial voltage of 7.2 volt, the charging current initially increases & then reduces and this reduced current maintains constant throughout.

4. BATTERY DISCHARGE:

Battery parallel discharge is shown in figure and design parameters are also shown below .Simulation results are shown both in display and waveform basis .Initially the battery charging is taken as 100% and nominal voltage of battery is taken as 7.2 volt .

LITHIUM ION-LITHIUM ION PARALLEL BATTERY DISCHARGE:

Combination of Lithium Ion-Lithium Ion parallel battery discharge is shown in figure and design parameters are also shown below .Simulation results are shown both in display and waveform basis .

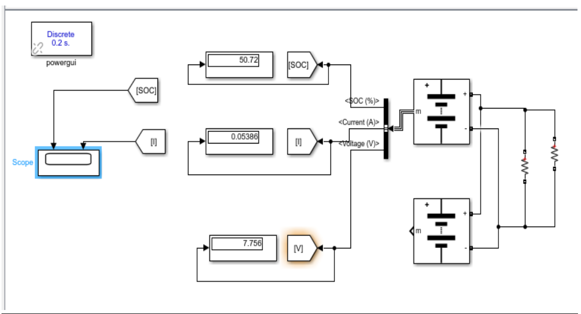

Figure4.1:- CIRCUIT DIAGRAM OF DISCHARGE OF PARALLEL BATTERY WITH LOAD RESISTANCE OF 72 OHMS FOR 500 HOURS

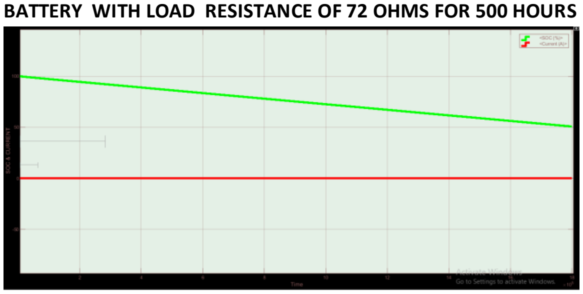

Figure 4.2:- SOC & CURRENT WAVEFORM OF DISCHARGE OF PARALLEL CONNECTED LITHIUM ION-LITHIUM ION BATTERY WITH LOAD RESISTANCE OF 72 OHMS FOR 500 HOURS

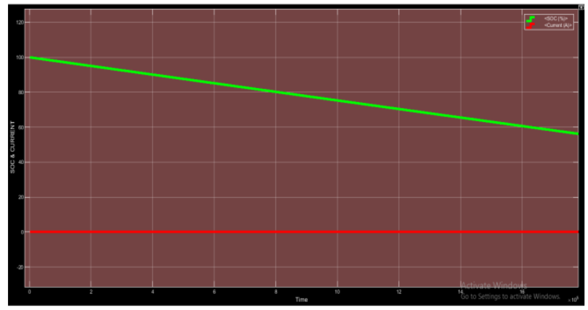

Figure4.3:- SOC & CURRENT WAVEFORM OF DISCHARGE OF PARALLEL CONNECTED LEAD ACID-LEAD ACID BATTERY WITH LOAD RESISTANCE OF 72 OHMS FOR 500 HOURS

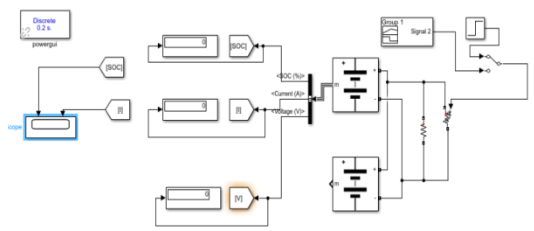

Figure4.4:- CIRCUIT DIAGRAM OF DISCHARGE OF PARALLEL BATTERY WITH LOAD AS STEP SIGNAL FOR 6 HOURS

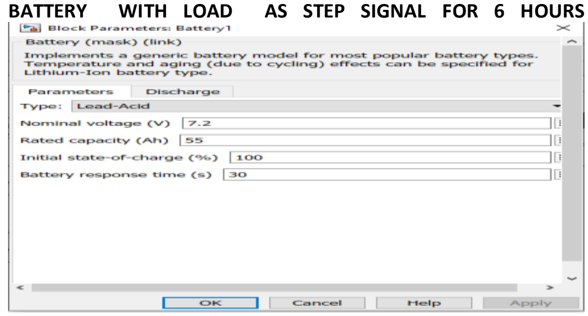

Figure4.5:-IMAGE SHOWING DETAILS OF STEP SIGNAL

Figure4.6:- FIGURE SHOWING STEP SIGNAL

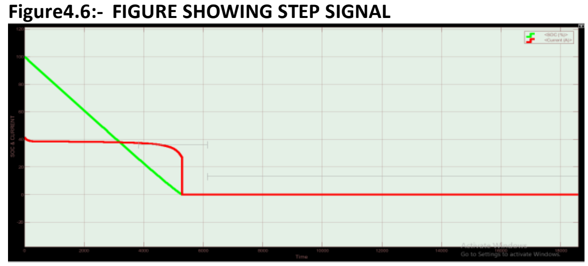

Figure4.7:- SOC & CURRENT WAVEFORM OF DISCHARGE OF PARALLEL CONNECTED LITHIUM ION-LITHIUM ION BATTERY

WITH LOAD AS STEP SIGNAL FOR 6 HOURS

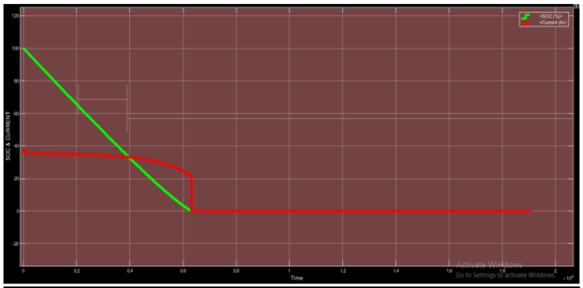

Figure4.8:- SOC & CURRENT WAVEFORM OF DISCHARGE OF PARALLEL CONNECTED LEAD ACID-LEAD ACID ACID BATTERY WITH LOAD AS STEP SIGNAL FOR 500 HOURS

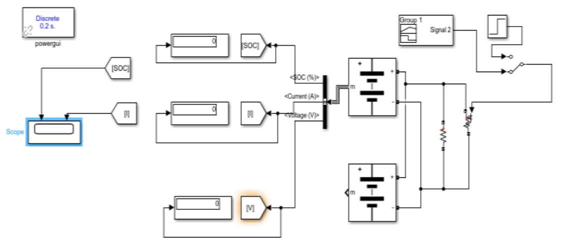

Figure 4.9:- CIRCUIT DIAGRAM OF DISCHARGE OF PARALLEL CONNECTED BATTERY WITH LOAD AS STEP SIGNAL WITH RAMP START DEVELOPED BY SIGNAL BUILDER FOR 500 HOURS

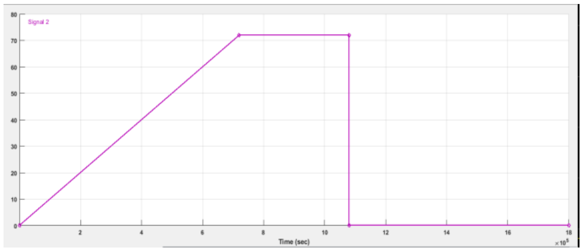

Figure4.10:-IMAGE OF STEP SIGNAL WITH RAMP START DEVELOPED IN SIGNAL BUILDER

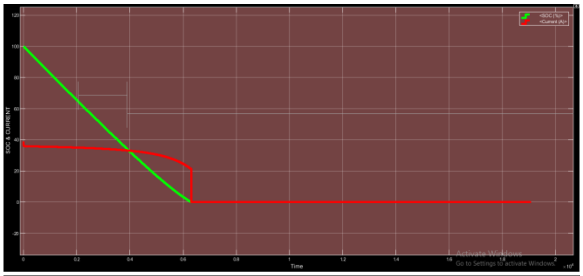

Figure 4.11:- CIRCUIT DIAGRAM OF DISCHARGE OF PARALLEL CONNECTED LITHIUM ION-LITHIUM ION BATTERY WITH LOAD AS STEP SIGNAL WITH RAMP START FOR 80 HOURS

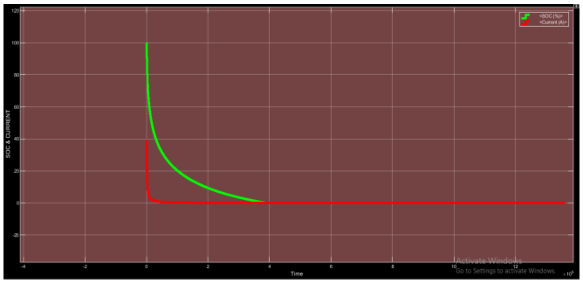

Figure 4.12:- SOC & CURRENT WAVEFORM OF DISCHARGE OF PARALLEL CONNECTED LEAD ACID-LEAD ACID BATTERY WITH LOAD AS STEP SIGNAL WITH RAMP START DEVELOPED BY SIGNAL BUILDER FOR 500 HOURS

ANALYSIS

ANALYSIS OF LITHIUM ION-LITHIUM ION PARALLEL DISCHARGE:-The SOC reduces to 50.72% in 500 hours and current remains low constant throughput for 72 ohms resistance at load .For step load , the SOC reduces to 0 in 140 hours & current reduces in step format to finally constant zero current in . For step with ramp start load also, the SOC reduces to zero in 40 hours & current droops to zero and becomes constant throughput.

ANALYSIS OF LEAD ACID –LEAD ACID PARALLEL DISCHARGE :-

The SOC reduces 58% in 500 hours and current remains low constant throughput for 72 ohms resistance at load .For step load , the SOC reduces to 0 in 170 hours & reduces in a step format to a low constant current . For step load with ramp start, the SOC reduces exponentially to zero in 110 hours and current remains constant low.

5. SIMULATION RESULT OF BATTERY CHARGING

TABLE 5.1 SIMULATION RESULT OF BATTERY PARALLEL CHARGING

CHARGING OF BATTERIES WITH INITIAL STATE OF CHARGE = 45%		
SOC	TIME	
LITHIUMION-LITHIUMION PARALLEL BATTERY CHARGING	80 SECONDS	100%
LEAD ACID-LEAD ACID PARALLEL BATTERY CHARGING	225 SECONDS	100%

TABLE 5.2 SIMULATION RESULT OF BATTERY DISCHARGING

DISCHARGING OF BATTERIES WITH INITIAL STATE OF CHARGE = 100% WITH LOAD AS 72 OHM RESISTANCE		
SOC	TIME	
LITHIUMION-LITHIUMION PARALLEL BATTERY DISCHARGING	500 HOURS	50.72%
LEAD ACID-LEAD ACID PARALLEL BATTERY DISCHARGING	500 HOURS	55.78%

6. CONCLUSION:- Parallel battery configuration helps increase the duration in which batteries can power equipment, but due to the increased amp-hour capacity they can take longer to charge than series connected batteries.

There is no limit to how many batteries you can wire in parallel. The more batteries you add in a parallel circuit, the more capacity and longer runtime be available. The more batteries in parallel, the longer it will take to charge the system. In a parallel circuit, the voltage remains the same, while the capacity is added together.

Parallel circuit is better than a series circuit because in case of any failure only the appliance connecting the faulty pathway will stop working. All the other pathways of the circuit remain unaffected by the failure.

Connecting batteries in parallel increases total current capacity by decreasing total resistance, and it also increases overall amp-hour capacity. All batteries in a parallel bank must have the same voltage rating. Batteries can be damaged by excessive cycling and overcharging. Advantages of parallel combination over series combination are: (i) In parallel combination each appliance gets the full voltage. (ii) If one appliance is switched on, others are not affected. (iii) The parallel circuit divides the current through the appliances.

Refrence:-

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