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Disparate Type of Battery Charging Strategies on Electric Vehicle Using H-Bridge Converter

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ABSTRACT

India's crude oil production falls to 2.67% in the fiscal year 2022 and air pollution has become a serious concern for India. According to World Air Quality Report 2022, India is the third- most polluted country in the world, with an average $PM_{2.5}$ concentration of 51.90, out of the 30 most polluted cities in the world, 21 of them are in India. The most polluted city in India and the world is Kanpur and Delhi. Air pollution contributes to the early deaths of 1.67 million Indians and 1.16 lakhs infants every year. Petrol or diesel vehicles are highly polluting and are being quickly replaced by fully electric vehicles. Electric Vehicle (EV) have zero tailpipe emissions and are much better for the environment. Electric vehicles use electricity to charge their batteries instead of using fossil fuels like petrol or diesel. Electric Vehicles offers plentiful advantages such as decreasing the pollution level and reduction in oil import bills etc. The demand for electric vehicles in India has been on the rise, but lack of enough charging infrastructure. This paper provides the modelling of Electric vehicle using MATLAB Simulink and SOC for disparate type of battery on the Electric Vehicles using H- Bridge converter. This paper deals with Nominal current discharge characteristics for Disparate Battery, A comparative study is also done for disparate type of battery. These results will help to improve the state of charging of battery and efficiency of Electric vehicle.

Keywords : Electric vehicle, SOC, H-Bridge converter

I. INTRODUCTION

Electric vehicles (EVs) use electricity as their primary fuel to improve the efficiency of conventional vehicle designs. EVs include all- electric vehicles, also referred to as battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). The Electric Vehicle (EV) market grows rapidly, the demand for fast and efficient battery charging services also increases.

In Electric Vehicle, battery technology research aims to push the limits for fast charging from multiple fronts, including the electrolyte and electrode materials, material architectures, and cell to pack design [1] [2]. The standard charging strategy is the Constant Current-Constant Voltage (CC-CV) due to its simplicity and ease implementation [3].

For an Electric vehicle design the pivotal part is estimating the parameters of various components like battery rating, motor rating, gear ratio etc. Selection of the type of motor depends on various factors like cost, efficiency, ruggedness reliability, torque capability etc. Depending on the vehicle application like whether it needs high speed or high range the battery composition should be taken (i.e) some Li-ion chemistries will have high discharge rates, some Li-ion chemistries will have fire safety like Lithium titanate batteries. Range anxiety is one of the deciding factors in case of an Electric vehicle whose accuracy depends on accurate estimation of state of charge (SOC) [4]

In this Electric vehicle is modelled using MATLAB Simulink. The SOC for disparate type of battery on the Electric Vehicles using H-Bridge converter are compared and analysed.

1 Simulation

A. *Software*

MATLAB Simulink software is used to design the Electric Vehicles .

B. *Model*

Electric vehicle design Simulink model consist of four parts,

(i) Vehicle body
(ii) Motor and controller
(iii) Battery
(iv) Longitudinal driver and Drive cycle source The design model of electric vehicle is shown in below

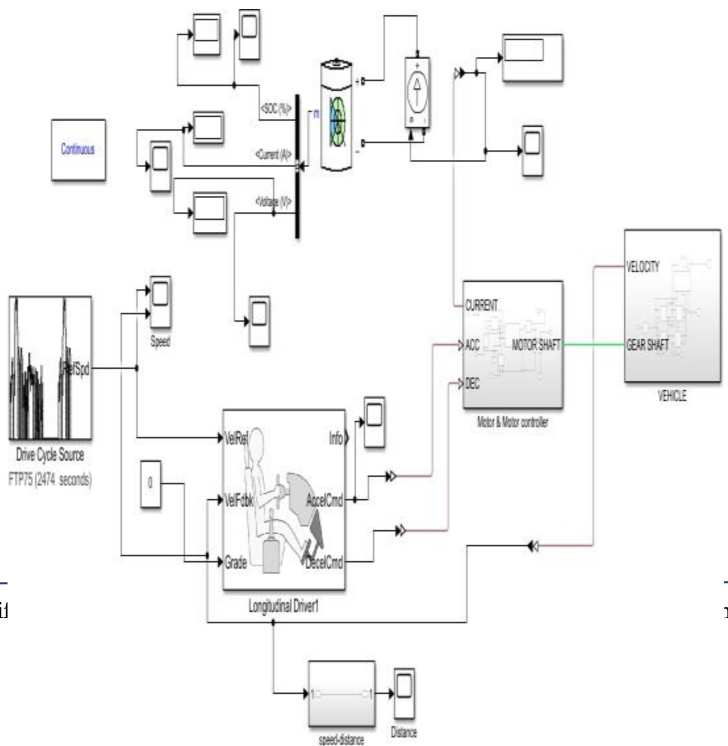


Fig.1.

Fig. 1. Design model of Electric vehicle

(i) Vehicle body

Electric vehicle body is connected to the four tier and the head wind speed is given as 10 m/s. The velocity of the electric vehicle body is connected to the longitudinal driver. Fig. 2. Shows the Design model of vehicle body

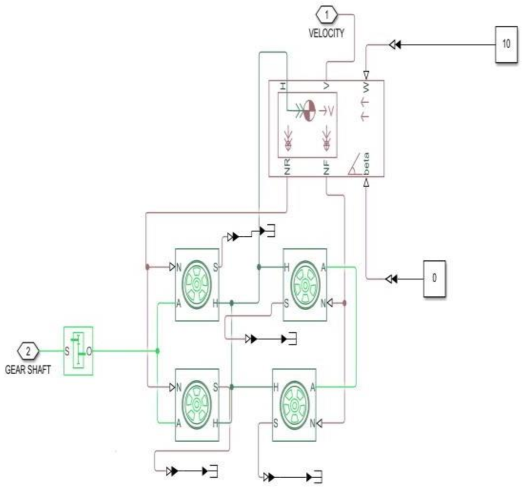


Fig. 2. Design model of vehicle body

The Electric vehicle body parameters are shown in Table.1.

Table.1: Mechanical Parameters of electric vehicle.

Sl.No	Parameters	Value
1.	Mass	1000 kg
2.	No.of.Wheel per axis	2
3.	Air density	1.18 kg/m^3
4.	Drag coefficient	0.4
5.	Front area	2 m^2

(ii) Motor and controller

PWM signal is given to H-bridge converter and the output is connected to the DC motor. The output of the motor shaft is connected to the gear of the electric vehicle body. Fig. 3. Shows the Design model of motor and H- bridge converter.

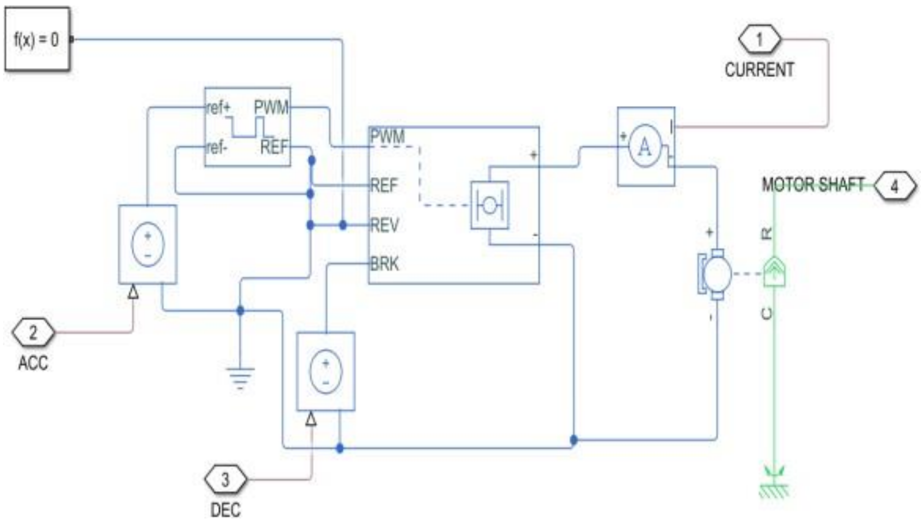


Fig. 3. Design model of motor and H-bridge converter

Table.2: Mechanical and Electrical Parameters of electric vehicle.

Sl.No	Parameters	Value
1.	DC Motor Armature resistance Armature inductance Rotor inertia	3.9 ohm 12e-6 H 0.01g*cm^-2
2.	H-bridge parameter Output voltage Bridge resistance Freewheeling diode Resistance PWM frequency	330V 0.1 ohm 0.05 ohm 4000 Hz

(iii) Battery

The Disparate type of battery such as lithium ion , lead acid ,Nickel-Cadmium , Nickel metal hydride is connected to the electric vehicle.Fig.4 shows the design model of battery. The SOC for different battery is analysed. The voltage of 514V is supplied to the battery. By using current sensor, the current is sensed from the motor and controller. The output is given to the battery. Finally the output of SOC (state of charging) ,voltage and current are measured.

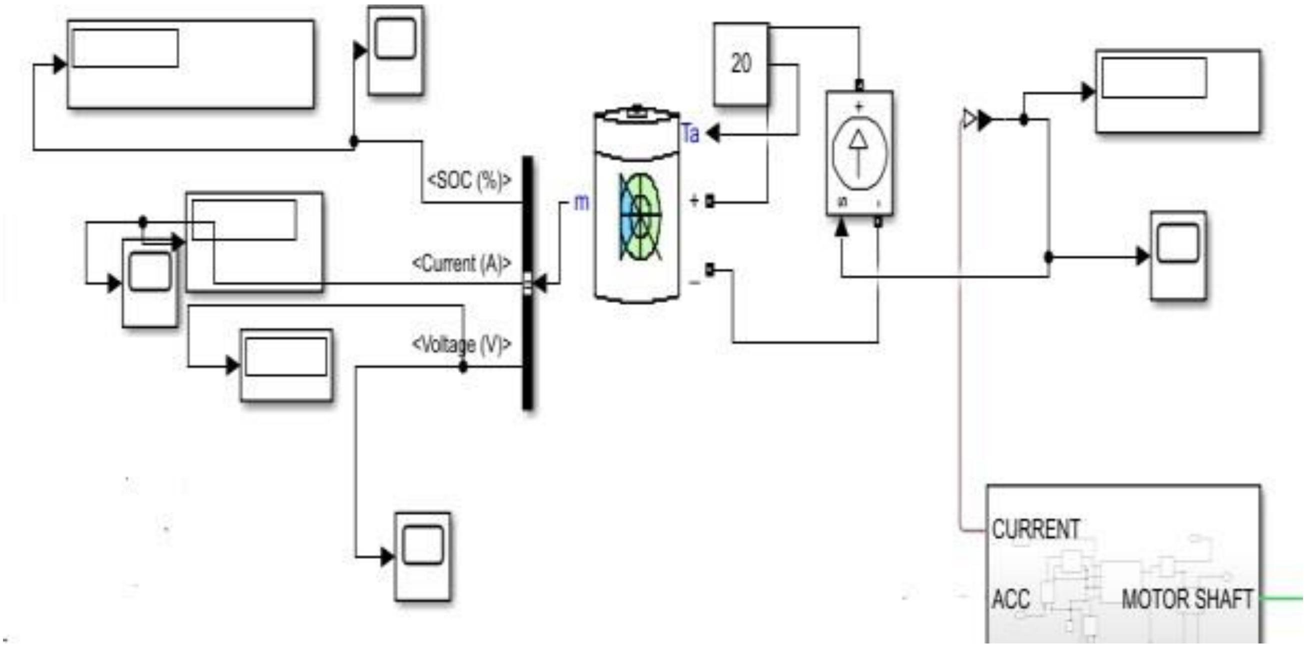


Fig. 4. Design model of Battery

Table.3: Electrical Parameters of electric Battery

Sl.No	Parameters	Value
1.	Voltage	514 V
2.	Capacity	97.2 Ah
3.	Temperature	20^{0}C

(iv) Longitudinal driver and Drive cycle source

A drive cycle source FTP75 output is given to the longitudinal driver circuits. In longitudinal driver, the acceleration and deacceleration output is connected to the H-bridge converter. The design model of longitudinal driver and drive cycle source is shown in below Fig.5.

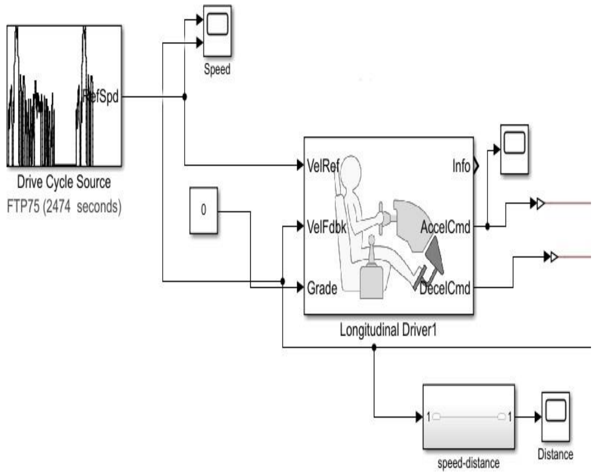


Fig. 5. Design model of Longitudinal driver and Drive cycle source.

II. Results and Analysis

The SOC for different battery is analysed

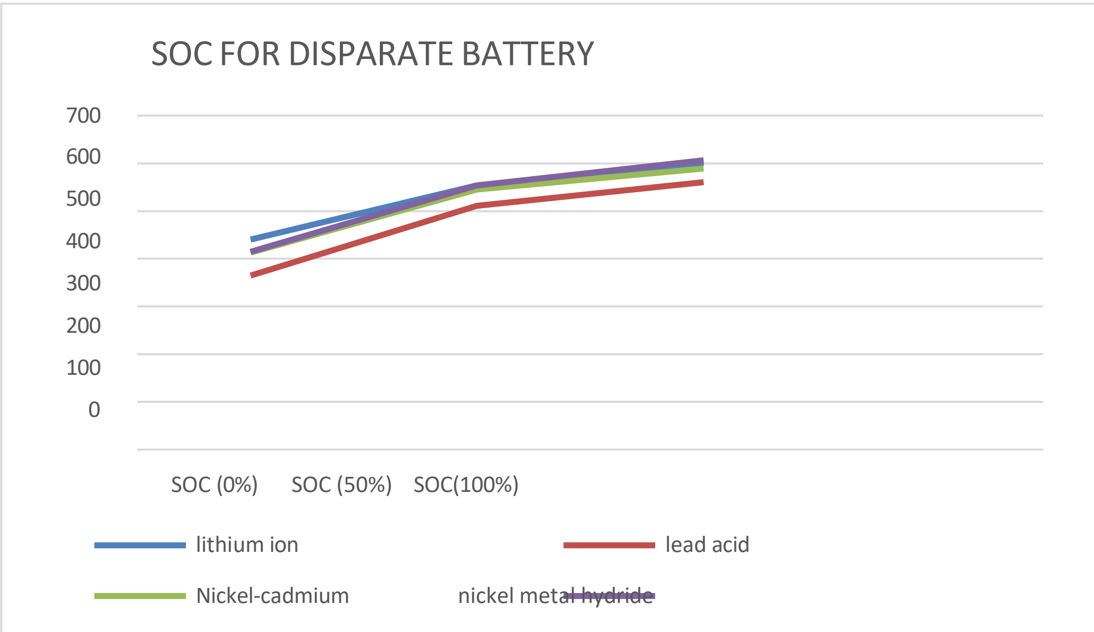


Fig. 6. Comparison graph for disparate battery

The lithium ion battery has highest voltage of

440.3 V for SOC (0%) .The lithium ion and Nickel metal hydride Battery has a highest voltage of 553.6 V for SOC(50%). The Nickel metal hydride Battery has a highest voltage of

606.5 V for SOC(100%).The data for the disparate battery is shown in Table. 4.

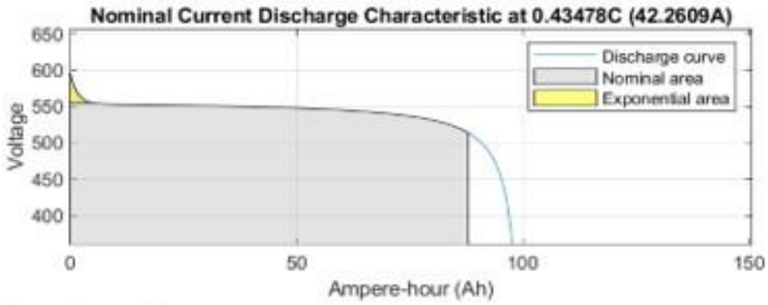
Table.4: SOC for different battery type

Battery Type	Lithium ion voltage	Lead acid voltage	Nickel- cadmium voltage	Nickel metal hydride Voltage
SOC(0%)	440.3	364.8	412.8	414.6
SOC(50%)	553.6	511.2	544.9	553.5
SOC(100%)	600.5	560.7	589.1	606.5

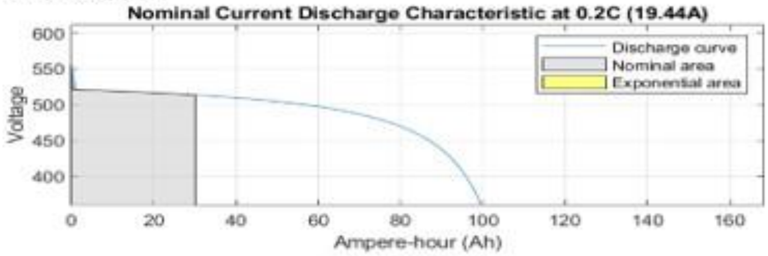
Nominal current discharge characteristics for Disparate Battery:

The discharge time of the lithium ion battery is very low compared to other battery. Next to Lithium battery the discharge time low is Nickel metal hydride. Nominal current discharge characteristics for Disparate Battery is shown in fig.7.

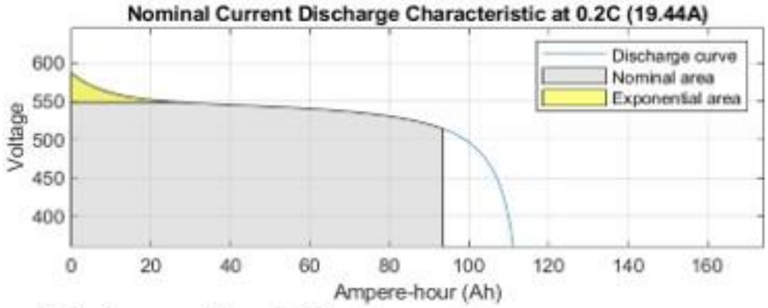
Lithium ion:



Lead acid



Nickel-cadmium



Nickel metal hydride

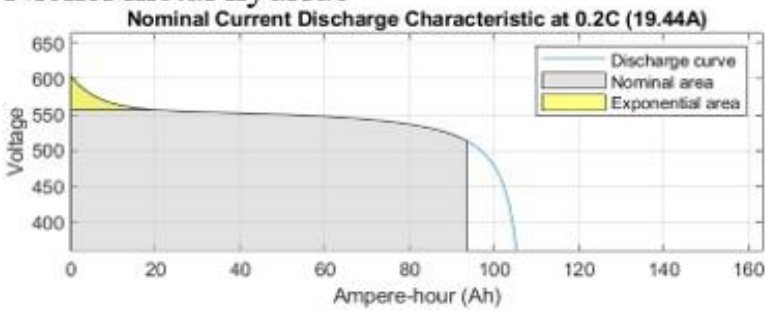
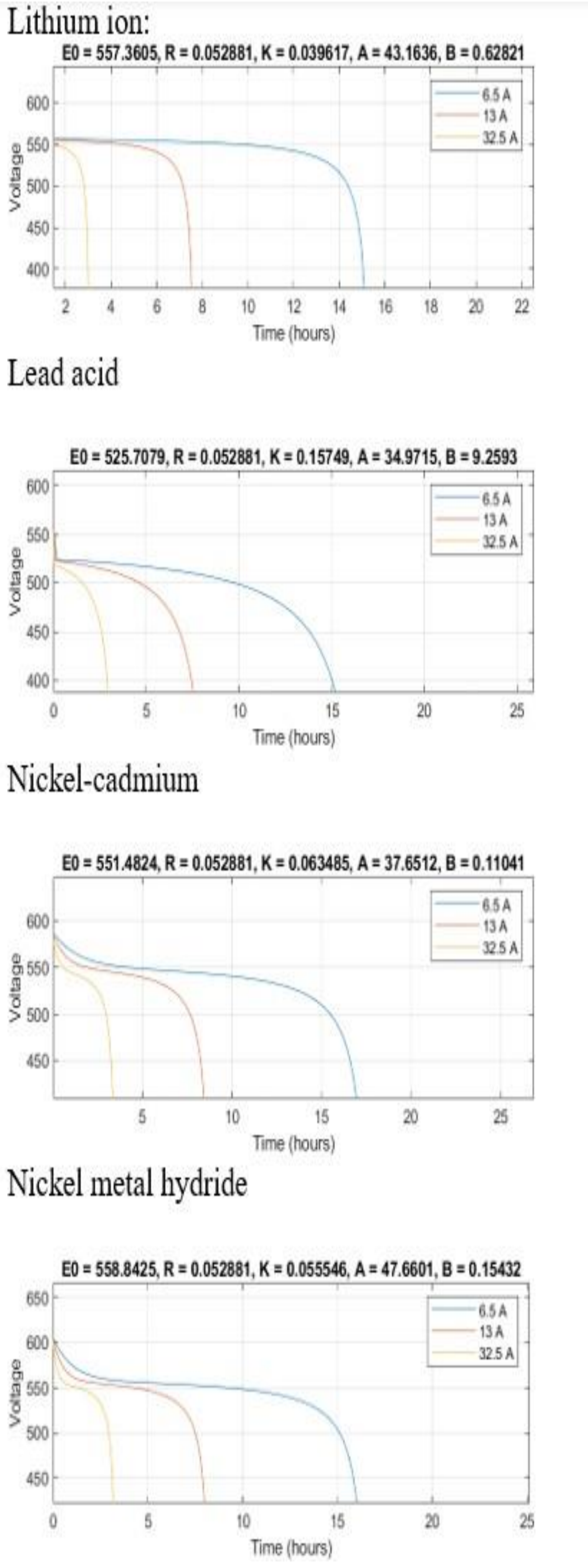


Fig. 7. Nominal current discharge for disparate battery

In lithium-ion battery, the discharging current for 6.5 A is 3 hrs. ,13 A is 7 hrs. and 32.5 A is 15 hrs. which is low compare to other battery. the voltage -time characteristic for disparate battery is shown in below Fig .8.

Fig.8.Voltage-Time Characteristics for disparate battery



2 Conclusion

This paper is deals about the modelling of Electric vehicle using H-Bridge converter in MATLAB Simulink. In this paper, The SOC for different battery is analysed, The lithium ion battery has highest voltage of 440.3 V for discharging current for 6.5 A is 3 hrs. ,13 A is 7 hrs., and 32.5 A is 15 hrs. which is low compared to other battery. Thus, the lithium- ion battery design minimizes the Power Losses in EVs and improve the Efficiency of Electric Vehicles.

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