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# Calculation of Charge and Health Status Condition in Battery Electric Vehicle

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**Abstract:- In Present scenario Internal Combustion Engines [ICE] is overcome by Electric Vehicles [EV] due to advantages like reduction in carbon-di-oxide [$CO_2$] emission, cost. Advancement in electric vehicles are extensively going on and one such concept is Battery management system [BMS]in Battery Electric vehicle. In Battery Electric Vehicle there are many sorts of batteries and from the literature survey Lithium Ion Battery are often concluded to be suitable because it is advantageous in weight, cost, energy density and many aspects. In Battery electric vehicle Battery plays a crucial role. Battery could also be overcharged or it's going to undergo faults. Hence a proper management system is required to control the Electric vehicle [EV] and it is called Battery Management System [BMS].**

***Keywords**:- Coulomb Counting, State of Charge, State of Health.*

## I. INTRODUCTION

In present scenario Internal Combustion Engine have been overcome by Electric Vehicles. To design an efficient electric vehicle many aspects, have to be considered. One such concept is Battery Management System. To design Battery Management System several concepts, have to be taken care like State of charge, State of Health, Noise- which is taken care by cell balancing method. The main function of the Battery Management System is to keep any single cell of the battery pack inside its safe operating area (SOA) by monitoring the following physical quantities: stack charge and discharge current, single cell voltage, and battery pack temperature. For an effective battery management system, State of charge and Health plays an important role. State of charge has to be determined properly. If it is not determined and if the battery is overcharged then life of battery may reduce. Hence to determine state of charge algorithms have been developed. Among the algorithms Enhanced coulomb counting and Kalman filter are found out to be suitable depending on the type of system.

## II. DESCRIPTION OF STATE OF CHARGE, STATE OF HEALTH:

In Present scenario Internal Combustion Engines [ICE] is overcome by Electric Vehicles [EV] due to advantages like reduction in carbon-di-oxide [CO2] emission, cost. Advancement in electric vehicles are extensively going on and one such concept is Battery management system [BMS]in Battery Electric vehicle. In Battery Electric Vehicle there are many sorts of batteries and from the literature survey Lithium Ion Battery are often concluded to be suitable because it is advantageous in weight, cost, energy density and many aspects. In Electric Vehicle fuel cost and maintenance cost is reduced. Hence it proves to be more advantageous.

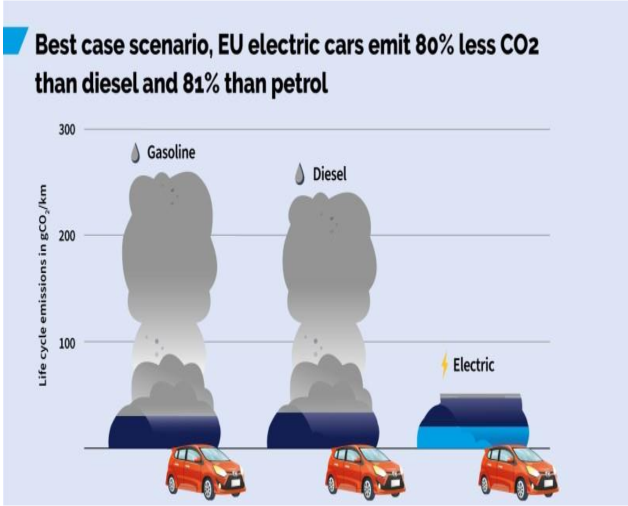



Fig 1:- Comparison of Internal Combustion Engine and Electric Vehicle

Electric vehicle is advantageous as it reduces $CO_2$ emission compared to Internal combustion engine.

## III. METHODOLOGY

The Coulomb-counting, consist of a temporal integrating of the battery current during charge and discharge. The accuracy of book-keeping methods is strongly dependent on the precision of current sensors. Coulomb-counting based algorithm are often used as a core technology for battery SOC estimation in BMS. They express the SOC as the ratio of available capacity to the nominal one. The remaining capacity in a battery can be calculated by measuring the current flow rate(charging/discharging) and integrating it over the time interval . Coulomb-counting is only based on direct measurement, so it is not hard to implement and gives enough precision of the SOC estimation in multimedia applications. It has always been a big concern to estimate the SOC for energy storage devices.

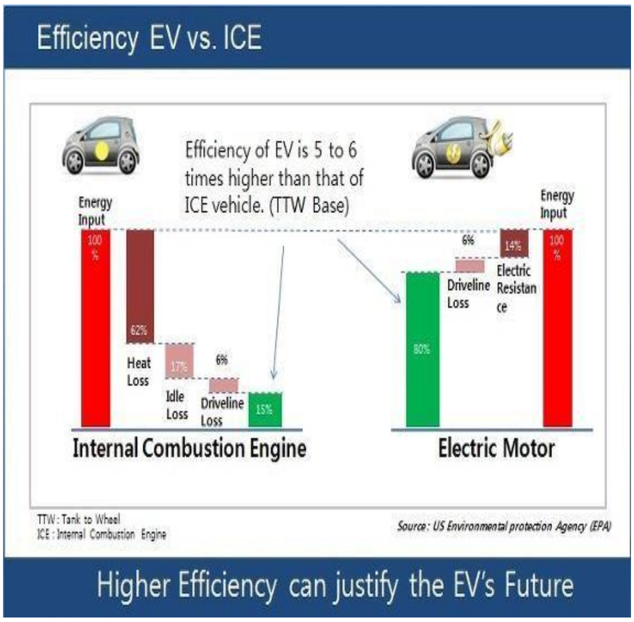



Fig 2:- Comparison of EV and ICE in terms of efficiency.

The estimation accuracy of SOC does not only give an information about the remaining useful capacity, but also indicates the charge and discharge strategies, which have a significant impact on the battery. Thus, a Li-ion battery may have different capacities **thanks to** aging, ambient temperature and self-discharge effects. Several methods for estimating SOC **are** introduced **within the** literature.

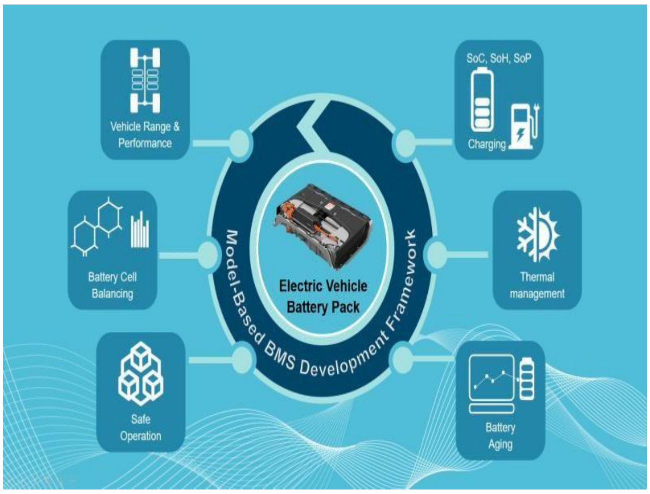



Fig 3:- Battery Management System

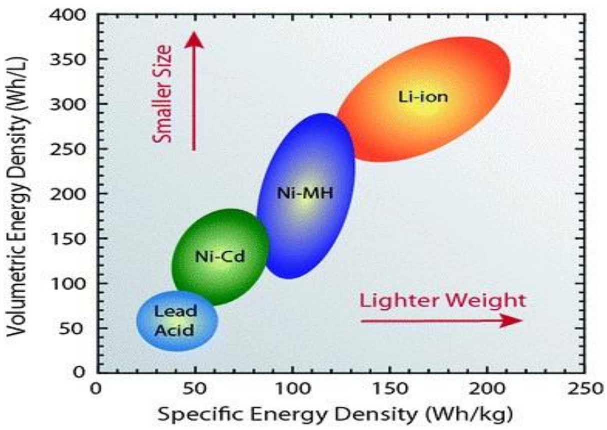



Fig 4:- Characteristics of a Li-ion Battery

Table 1. Review of SOC estimation methods

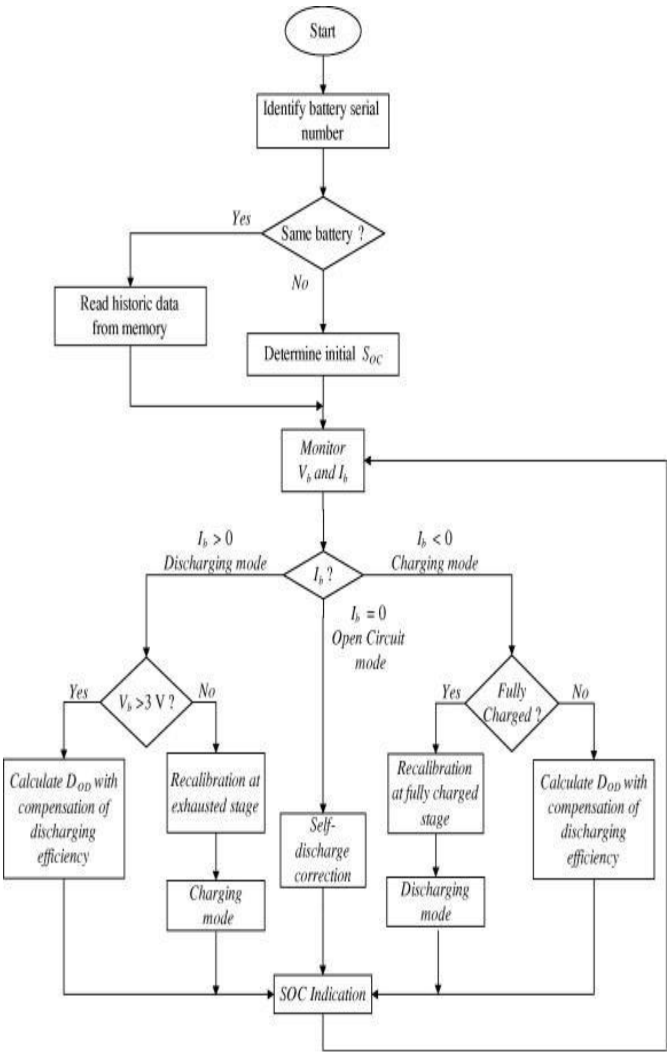
| SOC estimation method | Characteristics |
|---|---|
| **Electrochemical**<br>- Impedance spectroscopy [15] | - High accuracy<br>- Time consuming<br>- Hard to implement |
| **Model-Based**<br>- Kalman filter, extended Kalman filter [18,25,26]<br>- Lunenberger observer [21]<br>- Proportional integral observer [23]<br>- Sliding mode observer [12,22] | - Good precision<br>- Accuracy depends on the precision of the battery model .<br>- Not easy to implement |
| **Data-oriented**<br>- Neural Network [13]<br>- Fuzzy Logic [14]<br>- SVM [27] | - High accuracy<br>- Hard to implement<br>- Accuracy depends on the training data |
| **Book-keeping**<br>- Coulomb-counting [7,8] | - Average precision<br>- Simple to implement<br>- Cumulative errors<br>- Accuracy depends on sensors measurement |

The common equation to calculate the SOC is given by Eq. (1), where the SOC0 represents the initial SOC, bat I represents **the present** across the battery and, Qrated **is that the** nominal capacity of the battery.

$$SOC = SOC_0 + \frac{\int_{t_0}^{t_0+\tau} I_{bat}\Delta\tau}{Q_{rated}} * 100 \qquad (1)$$

➢ *Enhanced Coulomb Counting Flowchart:*

Coulomb counting method is suitable for only linear system. Enhanced coulomb counting method is suitable for both linear and nonlinear method. Battery voltage can be designed up to 1000V.




## IV. CONCLUSION

Electric vehicles are trending nowadays compared to internal combustion engine because of its advantages and less limitations. Global warming is effective with electric vehicles because of no emissions of gases. Limitations are the installed charging stations are not able to meet the increasing charging demand of Electric Vehicles. Finally, battery management system is used to control EV in estimating its state of charge and state of health conditions. For monitoring the charge and health status suitable algorithms are required and, in this proposal, Extended Coulomb Counting is found out to be suitable.

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