Research And Development of Different Batteries For Electric Vehicle

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Abstract- *This paper gives a thorough insight on the relatively revolutionizing and satisfying solution of energy storage through Batteries and provides an in-depth analysis of the same. This paper is aimed at understanding & analysing the properties and characteristics of batteries; to study its advantages, potential applications, limitations and disadvantages.*

Keywords- Electric Vehicle, Battery, Types of batteries

I. INTRODUCTION

Batteries are a major technological challenge in this new century as they are a key method to male more efficient use of energy. Global warming, finite fossil fuel supplies and city pollution conspire to make the use of renewable energy, together with electric transportation, a worldwide imperative. There is pressing need to design electrical energy storage systems to balance supply with demands, as renewable sources are intermittent, and to power the upcoming plug in hybrid electric vehicles or electric vehicles.

II) TYPES OF BATTERIES USED IN EV

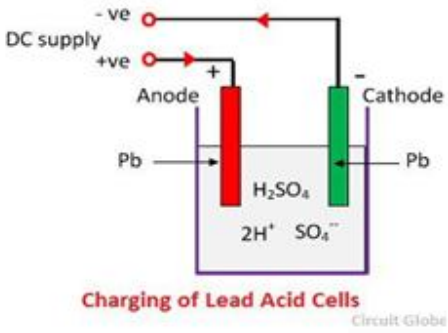
There are 3 types of batteries available today for electric vehicle which are stated as under

A) Lead Acid Battery
B) Lead Carbon Battery
C) Lithium Ion Battery

A) Lead acid Battery: -

[1]It is the battery that uses lead (sponge) and lead peroxide to convert their chemical energy to electric energy. Commonly used in power stations due to its high cell voltage and lower cost. Lead acid Battery contains main 5 components i) container ii) plate iii) active material iv) separator v) battery terminals

Working Principle: - When the sulphuric acidic molecules disintegrate into hydrogen ions and sulphate ions and move freely so if two electrodes are immersed in the solution and connected to DC supply then hydrogen being positive charged ion will move towards the electrode which is negative terminal. And sulphate ion being negative ion will move towards the positive electrode. So now each hydrogen take one electron from the cathode and each sulphate takes to negative ions from anode and react with water and form sulphuric and hydrogen acid.

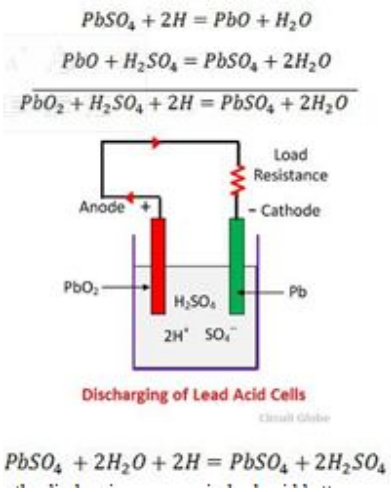


Above image shows the charging process in lead acid battery

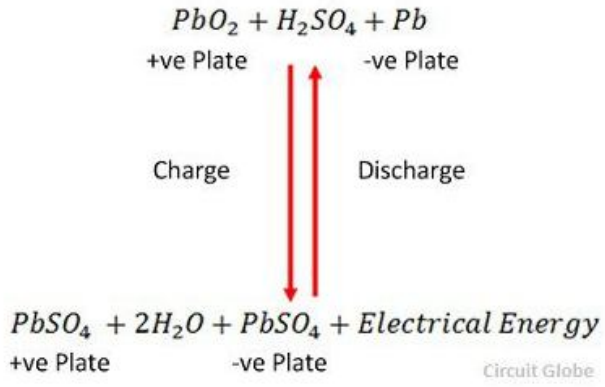
The oxygen which is produced from above all process will react to oxygen and form lead peroxide. Thus, during the recharging process the lead cathode remain as lead, but lead anode gets converted into lead peroxide which appears chocolate in color.

So now if DC power is disconnected and voltmeter is connected between two electrodes, it will show the potential difference between the electrode. If the wire is connected between them so current will flow from positive plate to negative plate through external circuit so we can say that the cell is capable of generating of electrical energy.

Charging and Discharging process: -



Above figure shows the discharging process in lead acid battery



The above reaction shows the charging and discharging process in the lead acid battery

Protection: - A battery management system is kept for the safety of the battery for its safety outside its area i.e. over current, over voltage, under voltage, over temperature, under temperature. The battery management system mainly works on area like

a) Including an open switch which is opened if the battery is operated outside its safe area
b) Actively controlling the environment, such as through heaters, fans, air conditioning or liquid cooling

B) Lead Carbon Battery: -

[2]Lead carbon battery generally have nominal voltage around 2V. It was first developed by Japan. It has life expectancy of 4200 cycles at 70% depth of discharge (DOD). It has nominal capacity of 500Ah / 1000Ah. Modern lithium ion batteries takes up to 3 hours for charging, but their discharging capacity is very low as compared to lead carbon battery and it shouldn't exceed 50-70% of the battery capacity. The fast charging is significant progress in lead carbon technology, since the charging current for daily cycle mode can be adjusted at 20-30% of the battery capacity. Therefore, it is possible to recharge a discharged battery within several hours.

Protection: -

The lead carbon battery is suitable for much bigger temperature range than standard lead acid battery because unlike others batteries it doesn't require external cooling system. The recycling rate of lead carbon battery is about 90% so which is the big pro for its comparison with lead acid battery and lithium ion battery, as the recycling of lithium ion battery remains the unsolved problem.

[3]Advanced Battery Mechanism: -

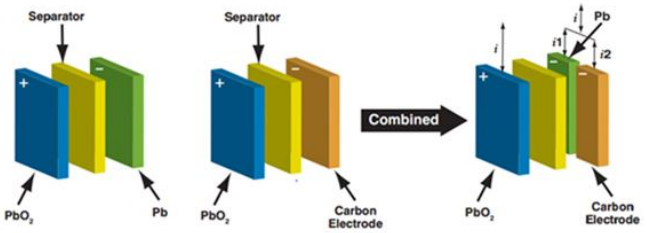


Figure 1: The classic lead acid develops into an advanced lead-carbon battery.

The negative plate is replaced with a carbon electrode that shares the qualities of a super capacitor.

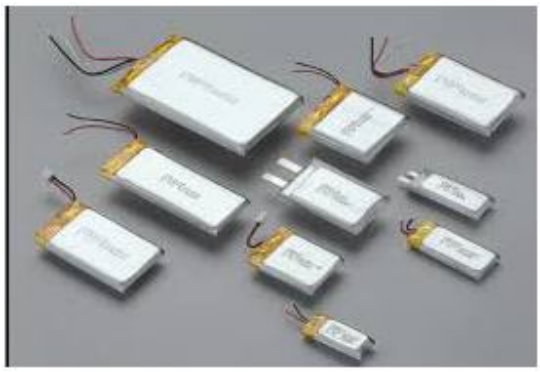
C) Lithium ion Battery: -

[4]Lithium is the lightest of all metals, and has greatest electrochemical potential and provides the largest energy density for the weight. Because of the inherent instability of lithium metal during charging, research shifted to a non-metallic lithium battery using lithium ions. In 1991, the Sony

Corporation commercialized the first lithium ion battery. The energy density of lithium ion is typically twice than of standard nickel cadmium battery and quite more than lead acid battery. Aging is a concern with most lithium ion batteries and many companies remain mum in this issue. The life expectancy of this batteries is generally around 3 to 4 years, but in some applications the battery is known to have served more than that. Manufacturers suggest to store the battery at cool place i.e. around 20 degree Celsius as in cool place the aging process slow down. The standard size of the lithium ion cell is 18mm x 65.2mm.

Advantages

- For higher capacities it has high energy density
- Only one regular charge doesn't required prolonged priming
- Self-discharge is less than half of other batteries
- Low maintenance and no periodic discharge is required



Limitations: -

- It always require protection circuit to maintain current within safe limits.
- It is essential to keep the battery in cool place as 40% charge reduces the aging effect
- Costly to manufacture about 300% times more than standard lead acid battery.

III. CONCLUSION

On comparing the above given batteries we found out that the high energy density is one of the chief advantages of lithium ion battery technology and the cost of other metal hydrides or other batteries are quite more than lithium ion though the cost of lithium ion battery is more than lead acid battery but the weight of the battery will be reduced very effectively and the availability of lithium ion batteries was quite manageable in comparison to other metal batteries. All the batteries are vulnerable to damage from excessive discharging and extreme temperatures. Lead acid batteries are generally less resilient to this kind of abuse and harmed if discharge too quickly deeply. Lead acid batteries lose potential cycles if they are discharge below 50% of their SOC. On the other hand, Lithium ion batteries can be discharged to about 80% SOC without any long term damage. Lithium ion batteries can be "fast" charged to 100% of capacity unlike with lead acid battery there is no need for an absorption phase to get the final 20% stored. The weight of the battery will also be reduced up to one third if we use lithium ion battery. Lithium ion battery are much cleaner technology and are safer for the environment.

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