LITHIUM - ION BATTERY
FOR
TELECOM APPLICATIONS

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Abstract

We present various aspects for use of Lithium-Ion Battery in various Telecom Applications in present as well as future scenario. The uses of Lithium-ion (Li-ion) Batteries have been increasing in our daily life day by day. Lithium-ion batteries are energetic, rapid rechargeable and having longer life. Lithium ion battery is also a better choice for various Telecom Applications as well as other applications. The demand of these batteries has been increasing rapidly. This paper also represents future requirement, applications, advantages, structure, challenges and other development for lithium ion battery.

1.0 Introduction

1.1 Lithium is a good conductor of electricity and can combine with many other metals to form alloys. Lithium ion batteries provide more and more energy in a smaller container. Lithium-ion batteries have many applications like cell phones, FTTX installations, remote terminals (such as in FTTX installations), access networks, BTS (Base Transceiver Stations) for wireless networks, cable networks, central offices, fuel cell powered system cars, artificial pacemakers, PCs, laptops, audio players, clocks, toys, cameras, automobiles etc. One can say lithium-ion battery would be next generation battery and future power house for telecommunication applications.

1.2 The lithium ion battery may be the alternate of VRLA battery because of higher energy densities, reliability, safety, low maintenance costs and the ability to operate in a wide range of environmental conditions for long periods.

1.3 VRLA batteries often suffer from premature and/or sudden capacity losses and thermal run away. The capacity loss of VRLA is also deceptive when the total lifecycle cost of power plant including maintenance cost, replacement and disposal costs are taken into account..

2. Features

2.1 The performance characteristics of lithium-based batteries have higher discharge rate capabilities, a relatively flat discharge curve and no venting of dangerous gases.

2.2 Though lithium-ion battery packs come in all shapes and sizes, but they all have about the same construction. A lithium-ion battery pack has an on-board processor to manage its performance. However, it makes them even more expensive than they already are. It's a pretty sophisticated little computer, and draws power from the battery itself. If the battery pack gets too hot during charging or use, the computer will shut down the flow of power to try to cool it down. A laptop's battery meter can show how much charge is left in the battery to the users. The onboard computer comprises: -

- One or more temperature sensors to monitor the battery temperature.
- A voltage converter and regulator circuit to maintain safe levels of voltage and current
- A shielded notebook connector that lets power and information flow in and out of the battery pack
- A voltage tap, which monitors the energy capacity of individual cells in the battery pack
- A battery charge state monitor, which is a small processor, handles the whole charging process to make sure the batteries charge as quickly and fully as possible.

2.3 If one tries to use laptop working in an extremely hot car, then this computer may prevent from powering up until things cool off. Before the cells are completely discharged, the battery pack will shut down to avoid damage to the battery pack. It also keeps track of the

number of charge/discharge cycles and sends out information so the laptop's battery meter can tell how much charge is left in the battery.

2.4 Lithium-ion battery cells are arranged in series and parallel to meet various voltage and capacity needs of the telecom industry. This “core” of cells is constructed in a manner designed to mitigate any propagation of individual cell failure and minimize capacity loss. The Battery Management System (BMS) controls all cell functions according to the manufacturer’s specifications, manages all parameters impacting on the battery’s performance and battery-to-battery communications, alarms, data logging of critical battery parameters and remote monitoring.

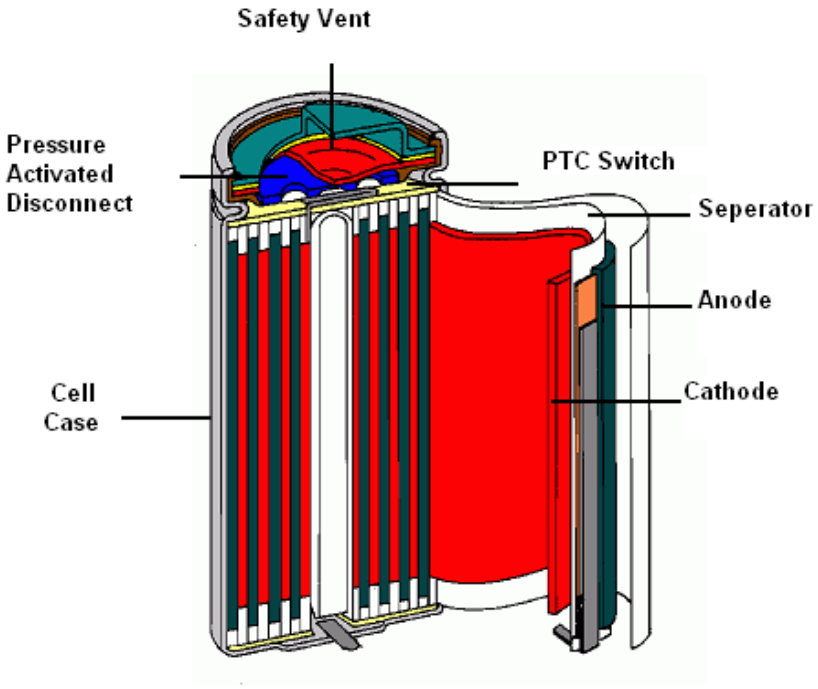
2.5 Lithium-ion battery may last two or three years from the date of manufacture whether it is used or not, but it will work about for 5 years if it is used properly.

3.0 Structure and Chemical Composition

3.1 Lithium batteries include lithium ion, lithium polymer, lithium metal polymer and a host of other lithium derivatives. Though may have different cathode materials such as cobalt, nickel manganese cobalt, manganese dioxide, iron phosphate.

3.2 The anodes of a lithium-ion battery are made of lightweight **lithium** and **carbon**. Lithium is also a highly reactive element, meaning that a lot of energy can be stored in its atomic bonds. This translates into a very high **energy density** for lithium-ion batteries. Lithium is also a good conductor of electricity.

3.3 Li-ion cell has cathode made of Lithium Cobalt oxide and anode made of specialty carbon and a separator layer. The battery has electrolyte which is a lithium compuound in an organic solvent. Li-ion battery is also equipped with safety measures and protective electronic circuits or fuses to prevent reverse polarity, over voltage and over heating. Li-ion battery also has a pressure release valve and a safety vent to prevent it from bursting.



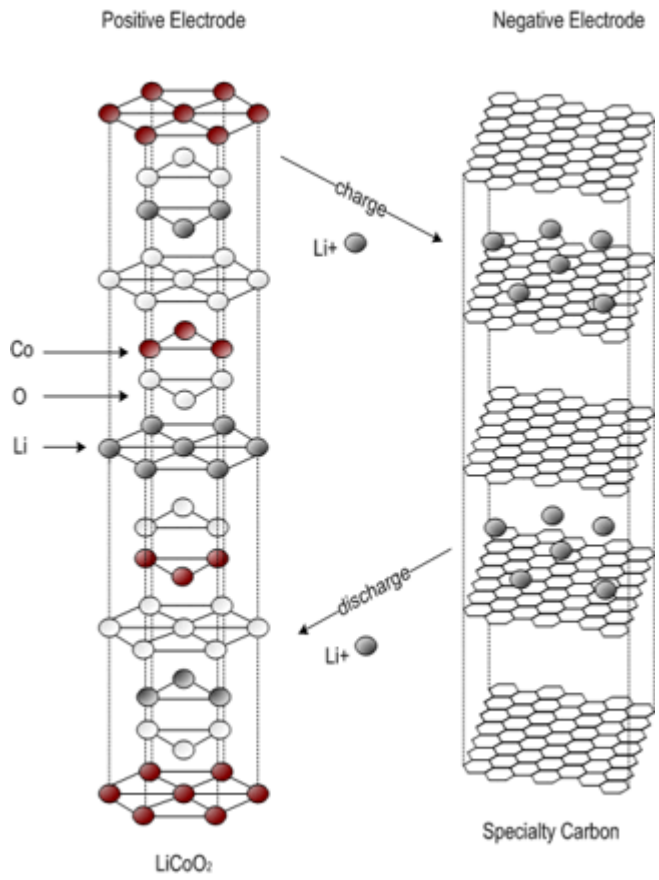
Cross-Sectional View of Li - Ion Cylindrical Cell

4.0 Chemical Reaction and Working Principle

4.1 The following chemical reaction that takes place inside the battery during charge and discharge operation:

$$LiCoO_2 + C_6 \underset{\text{discharge}}{\overset{\text{charge}}{\rightleftharpoons}} Li_{1-x}CoO_2 + C_6L_x$$

4.2 The lithium atom of cathode is ionized during charging and moves from layer to layer in the negative electrode. During discharge Li - ions move to the positive electrode which embodies the original compound.



5.0 Performance Evaluation

5.1 The Performance of lithium cell also demonstrates a wide temperature operating range (from -20ºC to +65ºC), it has very good depth of discharge characteristics and requires no maintenance.

To validate safety devices, the cells undergo a variety of testing where the cell's temperature and voltages are monitored under extreme event situations such as Crush Test, Impact Test, Heat Test, Over Current Test, Short Circuit Tests, etc.

6.0 Precautions while using lithium batteries

6.1 Constant current/constant voltage method is used for charging the lithium batteries. A constant current should be maintained to discharge the batteries.

6.2 Do not solder any wire directly onto the battery.

6.3 Verify the polarity of the batteries before charging to ensure that they are never charged with the polarity reversed.

6.4 Over discharge can damage the performance of the battery. Equip the battery system with a mechanism to prevent over discharge, especially in situations where the user may forget to turn the equipment off.

6.5 The batteries should be stored at room temperature. Do not place the battery on or near fires, stoves, or other high-temperature locations. Do not heat the battery. Do not place the battery in direct sunlight, or use or store the battery inside hot environment. Doing so may cause the battery to generate heat, rupture, or ignite. Using the battery in this manner may also result in a loss of performance and a shortened life expectancy

6.6 Do not short circuit the positive and negative terminals with any metal object.

6.7 Do not carry or store the batteries together with metal objects.

6.8 Do not pierce the battery with nails, strike the battery with a hammer, step on the battery, or otherwise subject it to strong impacts or shocks.

6.9 For better safety of the battery, the charging and discharging temperature should be beyond 45^{o} C and 60^{o} C respectively.

6.10 Do not disassemble or modify the battery. The battery contains safety and protection devices which, if damaged, may cause the battery to generate heat, rupture or ignite.

6.11 Do not leave the battery idle for longer time because batteries utilize a chemical reaction, battery performance will deteriorate over time even if stored idle for a long period of time.

6.12 Do not expose the battery to water or salt water, or allow the battery to get wet.

7 Advantages

7.1 Lithium-based battery technologies offer a cost effective solution given their higher energy densities, longer life and low maintenance costs.

7.2 Lithium-ion battery may work for about 5 years from the manufacturing date if it is used properly

7.3 Lithium ion batteries provide more energy in a smaller container, less space, less maintenance, better performance and high reliability.

7.4 Lithium-ion battery packs come in all shapes and sizes.

7.5 Battery charge/discharge state monitoring arrangement is available with the help of a small computer.

7.6 Lithium-ion batteries offer longer float life over VRLA batteries and give higher voltage of 3.6 volt.

7.7 Lithium batteries are generally much lighter than other types of rechargeable batteries of the same size.

7.8 Lithium-ion batteries have no memory effect and discharge capacity does not reduce on each charge/discharge cycle.

8.0 Issues, Challenges and Drawbacks

8.1 Consumer batteries usually incorporate over - current or thermal protection or vents in order to prevent explosion. Lithium-ion batteries may burst into flames occasionally. There is a small chance that, if a lithium-ion battery pack fails, it will burst into flame. Just two or three battery packs per million may have a problem. A kind of short circuit happens inside the lithium-ion battery due to separator failure. Since lithium-ion batteries can handle large currents, they may get very hot. The heat may cause the battery to vent the organic solvent used as an electrolyte, and the heat (or a nearby spark) can ignite it.

Once that happens inside one of the cells, the heat of the fire cascades to the other cells and the whole pack goes up in flames.

8.2 There are very few suppliers of large capacity lithium-ion batteries.

8.3 Capital cost of lithium battery is higher than traditional lead acid battery. However the cost of lithium battery depends upon the application and the site conditions where it will be deployed. If space is not the problem the lithium-ion battery may be an attractive solution.

8.5 Lithium-ion batteries are extremely sensitive to high temperatures. Heat causes lithium-ion battery packs to degrade much faster than the normal, resulting in poor performance.

8.6 Lithium-ion chemistry prefers partial discharge to deep discharge. On completely discharging a lithium-ion battery, may damage it irreparably. So it is best to avoid discharging the battery completely.

8.7 Lithium-ion battery starts degrading as soon as it leaves the factory. Lithium-ion battery may last two or three years from the date of manufacture whether one use them or not. It can work about 5 years if one uses properly.

8.8 A lithium-ion battery pack has an on-board computer to manage the battery and draws power for its own use and looses 5 % of its power every month while lying idle.

8.9 The additional circuitry for own use also makes the lithium battery more expensive.

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