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Lithium-Polymer Usb Rechargeable Battery

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Abstract: ***Interest in Rechargeable Batteries has risen drastically on account of environmental and energy concerns. The need for advancement in batteries has increased due to various applications in the field of science and technology. Therefore, rechargeable batteries were conceived and developed. Rechargeable batteries have high performance, high energy density, flexibility, light weight, better design and performance than non-rechargeable batteries. With increasing energy storage demands, calls for Li-ion rechargeable batteries. This paper focuses on technical concepts, brief ideas about the technology and progress in these rechargeable batteries. The rechargeable battery requires heavy industrial machinery for the manufacturing. The machines required are easily available in the market and the chemicals required for the battery are also easily available. The finished product requires only a single USB port for charging. All these alarming factors incline towards the development of rechargeable batteries, more crucially. The materials used in rechargeable batteries are environmentally-friendly and because of its multiple reusability, it contributes to minimal wastage.***

Keywords: Rechargeable Batteries , USB port, Lithium-Polymer batteries, Li-Po batteries, Sustainability, Heat Resistance, Durability.

I. INTRODUCTION

The invention of Batteries has drastically evolved in the field of technology. The batteries produced initially were non-rechargeable. In current times, two types of batteries are available in the market namely rechargeable and non-rechargeable batteries. The Indian market is entirely acquired by non-rechargeable batteries because the rechargeable batteries are not manufactured in India. The conventional Batteries , therefore, need to be upgraded to meet the requirements of the modern world. The USB Rechargeable Battery provides users with a product that is reusable and more durable than the current available regular batteries.The rechargeable battery requires heavy industrial machinery for the manufacturing. The finished product requires only a single USB port for charging which is available in many devices like mobile charging bricks, laptops, power banks, etc. The battery is also beneficial in the terms of cost in the long run of time compared to the non-rechargeable AA battery. The rechargeable battery works on the basic chemistry of charging and discharging of ions. During the process of discharging the ions move from anode to cathode and the reverse takes place during the charging. This process takes place in the presence of electrolyte which is a solid polymer in the case of USB rechargeable batteries. The discharging takes place at a linear scale in a timely manner.The USB rechargeable batteries are used in a variety of household devices such as radios, torches, low voltage lamps, RC controlled toys, TV and AC remotes and many more. which is uncertain in the case of non-rechargeable batteries. The USB rechargeable batteries provide better electronic protection in the terms of voltage, current and short circuit. The battery is protected against temperature as well as leakage. This makes the USB rechargeable battery the most advanced battery yet. They are also environmentally friendly and easily recyclable. In addition, LiPo is generally lightweight, robust, and flexible, which reduces the weight by more than 20 percent over the classic hard shell.

II. REVIEW OF LITERATURE

In the field of battery technology there are various combinations available for manufacturing anode, cathode and separator. Battery production not only consists of anode, cathode and electrolyte but also stacking, sealing ensuring the long life .Some of the most common methods which are practiced in the real world industry are listed here :

1) *Nickel Cadmium Batteries:* The active component of rechargeable nickel-cadmium batteries in the charge state consist of nickel hydroxide. The cathode in this combination is made of nickel hydroxide and the anode is cadmium. The electrolyte in the nickel cadmium battery is generally potassium hydroxide. Due to low internal resistance, the current conducting properties are quite good and can be charged rapidly. The selection of a separator is very important because voltage stability depends on it.
When there is high current discharge, pressure is generated on the battery shell and it leads to leakage of the electrolyte. Despite all the problems nickel cadmium cells offer a longer life and sustainability.

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2) *Nickel Metal Hydride Batteries:* The main component of a rechargeable nickel metal hydride battery in the charge state consists of nickel hydroxide. The positive electrode is made of a strong hydrogen storing metal hydride and the negative electrode is made of potassium hydroxide. The electrolyte is also made of potassium hydroxide. Compared to previous versions, batteries have a higher density and weight.
3) *Lithium Ion Batteries:* The lithium ion battery is one of the most used chemicals in the field of rechargeable batteries. The lithium ion is a special type of battery because both positive electrodes and negative electrodes are made of lithium ions only. During the discharging process the ions move from from the anode to cathode and vice-versa for the charging process. The electrolyte used for separating the anode and cathode is salt of lithium ion.

III. PROPOSED TECHNIQUE

A battery is an electrochemical device in which chemical energy is converted to electric energy.Two primary types of chemical batteries exist: Primary and secondary. A primary battery is non-rechargeable and is designed to only last one discharge cycle, after which it must be replaced. Secondary batteries are rechargeable. They can be discharged and recharged repeatedly.As we are all aware, a significant number of the modern electronic equipment we take for granted every day, such as mobile phones, laptop computers, music players, cameras and countless others are powered from batteries.

Basic Battery Operation : Two electrodes (positive and negative, made of two chemically different materials) are separated by an electrolyte - a solution that easily conducts ions (charged particles) from one electrode section to another section. An Electrical Load is applied to the cell, causing the cell to discharge. Electrons are pulled from the positive terminal of the battery through a chemical reaction between the positive terminal and the electrolyte. Electrons flow through the electrical load. Electrons return to the negative terminal. Electrons are put back into the negative side of the battery through a chemical reaction between the negative terminal and the electrolyte. Battery becomes discharged when the chemical reactions are not possible any longer. The chemicals have all been transformed into other chemicals that do not support electron producing chemical reactions.

IV. WORKING

The rechargeable battery is a small piece of technology but has a very complex process of working which involves transfer of ions, conversion of energy and storing of energy. The chemistry of the battery involves solid chemicals and there is also a presence of electric circuitry. This circuitry is used to monitor and store the charge and protect the battery against the electric failures.

1) *Chemistry:* In the battery chemistry as the name suggests lithium ions(li+) are involved in the reactions to drive the battery. The anode and cathode of the battery are both capable of absorbing the lithium ions. When the charging process is started the lithium ions travel towards the anode and when discharging is started lithium ions move away from the anode to electrolyte solution and towards the cathode. The main chemical used in the battery is lithium nickel manganese cobalt oxide(LiNiMnCoO2). The nickel in the battery provides high energy to the battery and when nickel is added to magnesium spinel it works best. The advantages of magnesium spinel are low internal resistance, high capacity rate, good stability and safety. The cathode of the battery is made from one-third nickel, one-third manganese and one third cobalt. The coupling in the battery is done between lithium manganese and lithium nickel manganese cobalt oxide. For better battery performance solid polymer electrolyte is used. The solid electrolyte makes the battery safer, reduces weight and does not contain. The polymer electrolyte is non-conducting material but it allows the ion-exchange between the electrodes. Previously the polymer was not conducting till 60 degree celsius, but this problem is solved by adding some conducting gel. This combination makes the battery cost-effective and safe.
2) *Charging:* In the charging process, positive material goes under oxidation and produces electrons. On the other side the negative material goes under reduction consuming the produced electrons. In charging the electrical energy is converted into chemical energy.When the electron travels from the positive part of the cell to the negative part of the cell, the current is produced in the external circuit. The electrolyte chemical used in the buffer serves as an internal path for flowing electrons between the cathode and anode.The output voltage of the USB adapter should be higher than that of the battery to drive the reverse current for charging. Charging the battery takes a few hours to charge. The low voltage chargers(without voltage and temperature sensing capabilities) can take up 14 hours or more to fully charge. The high voltage chargers can take up one to four hours for charging. The quality chargers can sense the overheating or overcharging and it will stop the charging.
   The chemical used in the battery is nickel-ion polymer which requires constant charging voltage source. If the voltage source is variable then it will damage the battery.

3) *Discharging:* In discharging the chemical energy is converted into electrical energy. The charging and discharging rates are referred to by the "C" rate of current. The "C" rate is defined as fully charging or discharge of battery in one hour. The typical charging and discharging theoretically referred to as C/2. The rate of discharge depends on various factors such as motion of chemicals inside the cell, the loss of energy due to internal resistance of the cell components. The terminal voltage of the battery is variable during both processes i.e charging and discharging but the variation is maximum during the discharging. If a customer keeps using the battery after the fluctuation in the device, it will discharge the battery more. When the discharge crosses a specified limit it will forcefully switch the polarity of positive and negative electrodes, this situation is termed as cell reversal. The cell reversal can occur under few circumstances such as:

a) When the battery is connected in the wrong way to ground during discharging.

b) When the battery is deeply discharged.

This battery reversal problem can be prevented because most of the modern devices have special sensing devices which can stop the deeply discharging process.When the battery is used over several periods of time the drain current of the battery goes high enough and with the help of internal resistance it creates huge voltage.

V. APPLICATION OF TECHNIQUE

The above technique as a whole acts to make a rechargeable battery which is used in numerous different devices. The battery consists of a USB port to charge and it consists of the steel terminal ends to discharge the current. This battery is used in many different low voltage devices such as radios, torches and different types of remote controls. The batteries can also power some high voltage devices if they are packed together and used in a combination. This technique of charging and discharging can be applied to other devices also. This technique has been in mobiles, laptops and even electric vehicles obviously at higher levels.

VI. LIMITATIONS

One of the negatives most frequently cited by users is that rechargeable batteries often have a lower voltage rating than single use. this could affect a device's output and performance..Better quality rechargeable batteries will extend lifespan, but inevitably their performance will still decline and eventually lead to the necessity for replacement. Rechargeable batteries are more costly than standard non-rechargeable AA batteries. The price difference between two batteries is due to less availability of rechargeable batteries within the market. The client requires a USB connector to energise the battery. it'll build the overall expense of the item. The opposite problem with USB connectors and ports is power and voltage supply. If a user unknowingly connects the battery to a high voltage supply it'll cause irreversible damage thereto. Sometimes it can burst the shell of the battery. Rechargeable batteries suddenly die and from that moment on won't work to any extent further unless they're recharged. However, these batteries are often recycled excellently.

VII. MARKET RESEARCH

At a CAGR of 12.3% between 2021 and 2030, the global lithium-ion battery market is anticipated to increase from USD 41.1 billion in 2021 to USD 116.6 billion by 2030. The market is expanding as a result of increasing demand for reliable power supply from critical infrastructures in the wake of COVID-19, increasing demand for plug-in vehicles, increasing demand for battery-operated material-handling equipment in industries due to automation, ongoing development of smart devices, and increasing adoption of lithium-ion batteries in the renewable energy sector. Between 2021 and 2030, the APAC lithium-ion battery market is anticipated to experience the fastest CAGR growth. The second and third largest markets for electric vehicles in the world, respectively, are China and Japan. The use of lithium-ion batteries has expanded as a result of ongoing developments in the consumer electronics and automotive sectors. These batteries have a number of advantages, including high power capacity, improved safety, and reduced pollution. However, the COVID-19 outbreak has affected and shut down production facilities globally, affecting all industry sectors. However, production has picked up in a few Chinese factories, bringing back certain necessities. Off-grid electrification is being planned in a number of APAC nations, especially in rural areas. Important market segments are

A. By Component

1) Cathode

2) Anode

3) Electrolytic Solution

4) Others

B. By End Use Industry

1) Electrical & Electronics
2) Smartphones & tablet/PC
3) UPS
4) Others
C. Automotive
1) Cars, Buses, & Trucks
2) Scooters & Bikes
3) Trains & Aircraft

VIII. DISCUSSIONS

The Lithium-Ion polymer batteries are the latest development in this field. These batteries have a slightly different construction than the other traditional batteries. They consist of several identical secondary cells which are placed parallel to each other. This increases the discharge current capability of the battery. In the lithium-ion battery it is placed in an organic solvent whereas in LiPo the electrolyte is in the form of solid polymer composite like polyethylene oxide and polyacrylonitrile.The different materials used for positive electrodes or also known as cathode are different lithium metal oxides such as $LiCoO_2$ (lithium Cobalt Oxide), $LiMn_2O_4$ (lithium Manganese Oxide) and $Li(NixMnyCoz)O_2$ (lithium Nickel Manganese Cobalt Oxide). The other materials used are vanadium oxides, olivines such as $LiFePO_4$ (Lithium Iron Phosphorus Oxide) and rechargeable lithium oxides. The most studied materials used for lithium-ion batteries are layered oxides containing cobalt and nickel. These materials show a very high stability at the high voltage ranges but cobalt has some drawbacks such as it is toxic in nature and also its availability is very limited in nature. Vanadium oxides possess great kinetics and it also has a large capacity. Due to the process of lithium insertion and extraction, the materials become amorphous and this results in limiting the cycling behavior. Some other materials like Olivines are nontoxic and they also have moderate capacity along with low fade due to cycling. But these materials have a very low conductivity..The processes for the manufacture of carbon anodes involve basic raw materials like calcined coke (filler coke) and coal-tar pitch. Traditionally, in the beginning of the process the petroleum coke is grinded and sized to various sizes for recombination in the proportions as per the requirements of the end use. The size of coke particles for the anode is in centimeters. We can use metallurgical coke or anthracite coal as fillers but it reduces the conductivity and increases the contamination in metal. The coke surface is made wet by adding the coke blend to the molten binder pitch. The mixing is done in proportions such that one part of binder pitch is added to three parts of coke in each batch. A constant temperature is maintained so that the mix has a consistency of plastic so that it can be shaped by molding or other extrusion techniques. Then the shaped objects are cooled down to harden the binder and sent for further processes. The next step in the process is baking. This is a long process taking about several weeks for completion. As the article reaches higher temperature it undergoes pyrolysis and the coke is fused to solid mass. After the cooling process, the sand or other packing materials are removed and the baked articles are then further checked for various defects. Once this all is over the final product is used as carbon anodes.

IX. CONCLUSIONS

USB Rechargeable Battery is a revolutionary step in the field of battery. The technology used behind this is developed considering the current economic and environmental scenario. This will help to reduce pollution and at the same time help the users economically. This battery is the first of its kind that will be manufactured in India making it easily available to everyone.Lithium batteries have developed over the past 30 years to become one of the most promising and new and efficient battery systems. Primary and secondary lithium batteries have gained widespread use in communications, foreign affairs, portable tools, military devices, and industry. The next five to ten years will continue to show heavy lithium battery growth and prove to be a master in standard uses as well as development into new applications such as electric and hybrid of all electric vehicles.

The successful facility must not allow any sort of recycling, storage, handling, and transportation procedures to become routine. These procedures must be continually revised and checked to verify accuracy extremely and efficiently. Once a recycling facility considers what exactly their processes are as perfect and without flaw, an accident or incident becomes possible.Each type of lithium battery requires slightly different processing/handling. In reality more and more, the specific reasons for differing processes may be due to the environmental concerns of the materials within the batteries, the size of the batteries, the reactivity of the batteries, safety concerns, differing states of charge of the batteries, and/or different materials to be recovered by us in time.

An analysis of each battery type should be performed and the results should be reviewed for chemical compatibility, moderate permeability and life of the process, flammability, toxicity, reactivity, safety, and for environmental concerns.

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The recycling of lithium batteries regardless of size or chemistry is a very and extremely complicated process. There have been many incidents that are always involving these high-energy batteries that are always going to be and the simplest, most obscure aspects of the procedure usually cause these incidents to occur. Toxco Inc., to date, is one of the oldest refined and most successful lithium and polymer battery recycling companies in the world. Although many companies do recycle some or most types or sizes of lithium batteries recovering one or two or more materials from the battery, Toxco Inc or so.Unlike the conventional battery, the USB Rechargeable battery can also be used multiple times and they provide a better discharge rate even after 100 charges. These batteries are long lasting, protected against most of the electrical failures and are leakage free. Being able to get charge through a single USB port without the need of any cable makes them extremely convenient to use.

X. FUTURE WORK

In future if this technology has to continue and move forward we need to take some major steps in all departments. As mentioned in limitations we need to make some improvement in maintaining high voltage.Also we need to improve the charging aspect of these batteries. As we all know Tesla cars have Supercharging which charges the entire car's massive battery in about 30 mins. Smartphone laptops also have this rapid charging technology where 10mins charge fuels about 50% of the battery. We need to get some of this technology into these batteries also to make the charge times less so that the user doesn't always have the fear of charging in his mind. While there are many inventions in the past decade or so the battery composition has not evolved drastically. We are still using lithium based batteries from the past decade. They are good but to take the game up a notch we need some improvement in this department also. There are many studies and researches going on in this field but the battery which looks promising is a Graphene based battery. These batteries can improve a lot of problems which we have with current gen batteries such as charging time, low capacity, drop in voltage,etc. Graphene based batteries are able to hold and store their charge for much longer then the traditional batteries. They can also charge at ridiculous speeds which would make charging just a breeze.

XI. APPENDIX

The electrochemistry of these batteries now covers a huge range of active materials such as LiCoO2, LiNio2 and its Co doped derivatives. Harding uses LiCoO2 chemistry.

Charging & Discharging Chemical Reaction

The Lithium Ions are transferred from the layers of the lithium to the carbon material that forms the anode when the lithium-polymer cells are first changed.

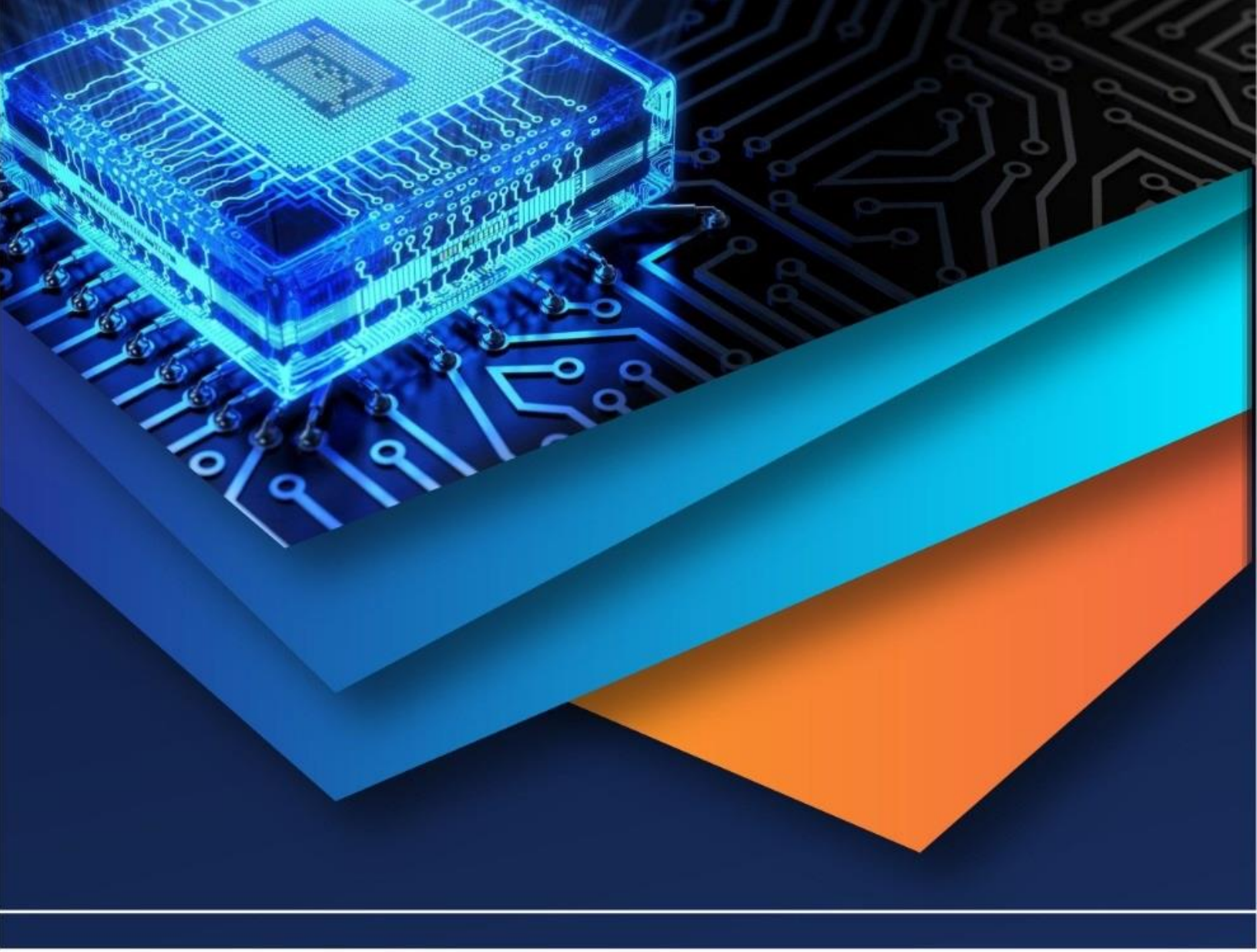
$LiCoO_2 + 6C \rightarrow Li_{(1-x)}CoO_2 + Li_yC_5$

Subsequent reactions of charging and discharging take place based on the motion of the lithium ions between anode and cathode.

$Li_{(1-x)}CoO_2 + Li_xC$ ---> $Li_{(1-x+dx)}CoO_2 + Li_{(x-dx)}C$

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