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IoT Based Comparative Study of Different Batteries

M.J.HEDAU[1]. M P DHORE[1], M. C. NAIDU[2]
Shivaji Science College, Nagpur1
Hilsop College,Nagpur

ABSTRACT
The present paper describes the study of different types of batteries .It is a collection of one or more cells undergoes the chemical reactions which causes the flow of electrons within a circuit. There is lot of research and advancement going on in battery technology, and as a result, breakthrough technologies are being experienced and used around the world currently. Batteries came into play due to the need to store generated electrical energy. As much as a good amount of energy was being generated, it was important to store the energy so it can be used when generation is down or when there is a need to power standalone devices which cannot be kept tethered to the supply from the mains. Here it should be noted that only DC can be stored in the batteries, AC current can't be stored
KEYWORDS: *Cells, battery, anode, cathode IoT*

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I. INTRODUCTION

1.1 Batteries are usually having the following components;
Anode, Cathode and electrolytes
During charging cathode is a negative electrode that produces electrons to the external circuit to which the battery is connected, which causes a potential difference between the two electrodes. The electrons naturally then try to redistribute themselves, this is prevented by the electrolyte, so when an electrical circuit is connected, it provides a clear path for the electrons to move from the anode to the cathode thereby powering the circuit to which it is connected.
1.2 Types of Batteries
Batteries generally can be classified into

1. Primary Batteries
2. Secondary Batteries

Primary batteries are not rechargeable and
Secondary batteries are rechargeable
2, **Types Of Batteries**
Chemical Batteries are modern batteries use a variety of chemicals to power their reactions.
Zinc-carbon battery: The zinc-carbon battery is an inexpensive
Lithium-ion battery (rechargeable): Lithium battery is igh-performance devices used in cell phones, digital cameras and even electric cars. A variety of substances are used in lithium batteries, but a common combination is a lithium cobalt oxide cathode and a carbon anode.
Lead-acid battery (rechargeable): This is the used in a typical car battery. The electrodes are usually made of lead dioxide and metallic lead, while the electrolyte is a sulfuric acidIn lithium-ion (Li-ion) batteries, energy storage and release is provided by the movement of lithium ions from the positive to the negative electrode back and forth via the electrolyte.
Today, among all the state-of-the-art storage technologies, Li-ion battery technology allows the highest level of energy density. Performances such as fast charge or temperature operating window (-50°C up to 125°C) can be fine-tuned by the large choice of cell design and chemistries. Furthermore, Li-ion batteries display additional advantages such as very low self-discharge and very long lifetime and cycling performances, typically thousands of charging/discharging cycles.

Solid-state batteries:
Monocrystalline silicon PV panels: It is prepared from a single cylindrical crystal of silicon. This is the most efficient photovoltaic technology, usually 15% of the sun's energy converted into electricity.
Polycrystalline silicon PV panels: This is also called a multi crystalline cells, polycrystalline silicon cells are made from cells cut from an ingot of melted and recrystallised silicon..
Thick-film silicon PV panels: This is a variant on multi crystalline technology where the silicon is deposited in a continuous process onto a base material giving a fine grained, sparkling appearance. Like all crystalline PV, it is normally encapsulated in a transparent insulating polymer with a tempered glass cover and then bound into a metal framed module.
Nuclear Battery: Such type of battery are prepared from a device which uses the energy from the decay of radioactive isotope to generate electricity. An atomic battery does not use a chain reaction to generate electric energy. The natural decay of radioisotope generates heat and then it is converted to electricity. In oppose to nuclear reactors where artificial triggered nuclear fission or fusion happens, the nuclear atomic battery uses only spontaneous decay of the isotope. The nuclear battery has a very long life. High energy density is another notable characteristic of an atomic battery, The battery is highly reliable, Efficient use of post products from nuclear fusion and fission in the battery.

This type of power supply is required for applications such as industrial machines, agriculture, remote monitoring systems, spacecraft and deep-sea probes. The need for this type of power source is especially high for military purpose, radar technology and satellites. For very high power generation Nuclear reactor might be used but for intermediate power range of 10 to 100 kilowatts (KW), the nuclear reactor presents huge technical problems along with significant financial problem. Due to the short and unpredictable lifespan of chemical batteries, they can't be used. Also, the amount of chemical fuel to provide 100 KW of energy for any significant period of time would be too large in size. Although fuel cells and solar cells require little maintenance, but fuel cells are too expensive for such small, low-power applications, and solar cells need plenty of sun. Thus it is the need of the hour to find ways to convert small amount of radiation to produce electricity.
Natural radioactivity produces radiation that has energy. Atomic/Nuclear Batteries harness this energy. Quantitative first principles that enable this are discussed elsewhere. This document takes the discussion forward to methods of harnessing this energy. The properties like energy and power density, domains of applications and the cost per unit energy depend primarily on the material in use, as noted in; while the efficiency and output potential depend on the type of conversion used.
Thermal converters (radioisotope thermoelectric generators - RTGs) use the thermal energy of the radioisotope decay to generate electricity. Methods to accomplish this include heating up a thermocouple, producing infrared radiation from hot metals to power "solar cells", using the Stirling Engine and many more. These have reached an efficiency of upto 23% experimentally and 30% in theory.
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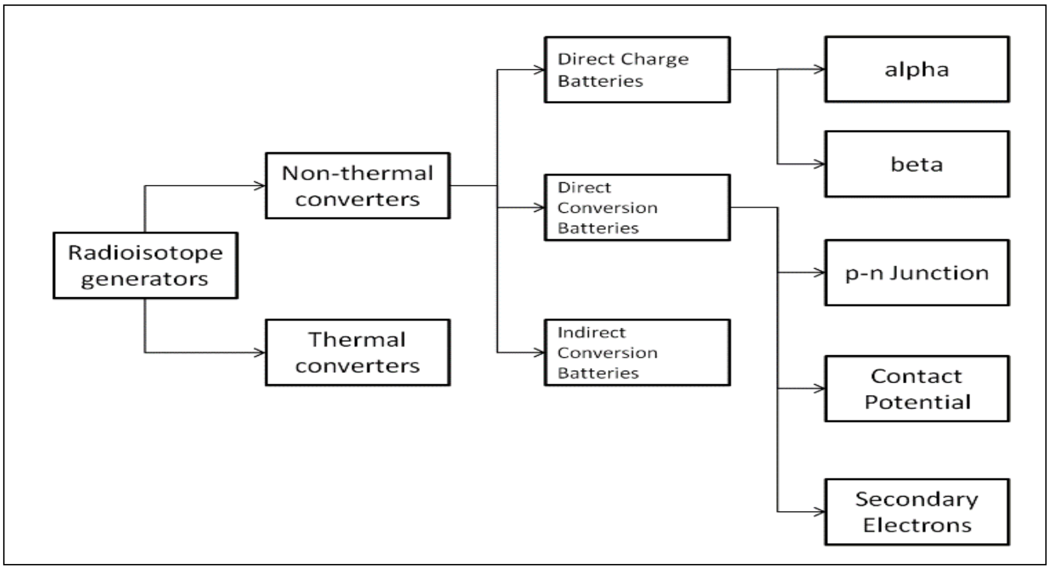

Fig (1)

Block Concept (Fig 1)
Indirect conversion typically involves two steps of conversion. The radioactive decay consisting of either alpha or beta particles is impinged on some radio luminescent material like phosphor to produce photons and then is collected using photodiodes or 'solar cells'. Optimization has to be done on the structure of the photo diode, the

phosphor filling, the method to collect photons and the placement of the radioactive material. Also, the optical properties of the conversion processes need to be matched. At best, we can expect an overall efficiency of 2% at 3.5V open circuit voltage. Theoretically this efficiency can be 25%.

Direct conversion uses the radioisotope decay to directly drive a device that converts these charged particles to electricity. The betavoltaic effect uses beta particles to generate electricity as in the photovoltaic effect, say using a photodiode. The electrons can be collected wither using a 'solar cell' configuration or using a contact potential difference (using metal contacts of Different work functions to drive the electrons). We could also generate secondary electrons from an irradiated surface and use them to drive a load. This works with gamma radiations too. The efficiencies range from 0.35% for secondary electron method to 2% for betavoltaic method. The secondary electron method can produce upto 500,000V at 50mW.

SELECTING THE RIGHT BATTERY FOR YOUR APPLICATION

One of the main problems hindering technology revolutions like IoT is power, battery life affects the successful deployment of devices that require long battery life and even though several power management techniques are being adopted to make the battery last longer, a compatible battery must still be selected to achieve the desired outcome.

Below are some factors to consider when selecting the right type of battery for your project.

Energy Density: The energy density is the total amount of energy that can be stored per unit mass or volume. This determines how long your device stays on before it needs a recharge.

Type		Energy Density
Chemical Batteries	Lithium-ion(Li-ion)	50-150 W-h/L
	Nickel Cadmium(Ni-Cd)	140-300 Wh/L
	Nickel-Metal Hydride(Ni-MH)	250-693 W-h/L
Solid State Batteries	Monocrystalline Silicon Cell	12.6 W-h/L
	Polycrystalline Silicon Cell	20.2 W-h/L
	Thin film cell	7.2 W-h/L
Nuclear Batteries	Nuclear Fission	$428X10^9$ W-h/L

Power Density: Maximum rate of energy discharge per unit mass or volume. Low power: laptop, i-pod. High power: power tools.

Type		Power Density
Chemical Batteries	Lithium-ion(Li-ion)	150 W-h/Kg
	Nickel Cadmium(Ni-Cd)	300 W-h/Kg
	Nickel-Metal Hydride(Ni-MH)	600 W-h/Kg
Solid State Batteries	Monocrystalline Silicon Cell	12.6 W-h/Kg
	Polycrystalline Silicon Cell	20.2 W-h/Kg
	Thin film cell	7.2 W-h/Kg
Nuclear Batteries	Nuclear Fission	$428X10^9$ W-h/Kg

Safety Precautions : It is important to consider the temperature at which the device you are building will work. At high temperatures, certain battery components will breakdown and can undergo exothermic reactions. High temperatures generally reduces the performance of most batteries.

Chemical Batteries:

A personal protective equipment (PPE) such as chemical splash goggles and a face shield.

Wear acid-resistant equipment such as gauntlet style gloves, an apron, and boots. Do not tuck your pant legs into your boots

Be aware of the chemical hazards posed by batteries.

Solid State Batteries:

Solid lithium (Li) metal anodes in solid-state batteries are replacing graphite anodes in lithium-ion batteries for higher energy densities, safety, and faster recharging times. l.

Stable solid electrolyte interphase (SEI) was found to be the most effective strategy for inhibiting dendrite growth and achieving higher cycling performance. Solid-state electrolytes (SSEs) may prevent dendrite growth, although this remains speculative.

Nuclear Batteries:

Nuclear power plants are some of the most sophisticated and complex energy systems ever designed. Any complex system, no matter how well it is designed and engineered, cannot be deemed failure-proof. The reactors themselves were enormously complex machines with an incalculable number of things that could go wrong. When that happened at Three Mile Island in 1979, another fault line in the nuclear world was exposed.

One malfunction led to another, and then to a series of others, until the core of the reactor itself began to melt, and even the world's most highly trained nuclear engineers did not know how to respond. The accident revealed serious deficiencies in a system that was meant to protect public health and safety.
the specific energy of commercial chemical cells.

Limitations :
Chemical Batteries:
Relatively low energy density compared with newer systems. Memory effect the NiCd must periodically be exercised to prevent memory. Environmentally unfriendly the NiCd contains toxic metals. Some countries are limiting the use of the NiCd battery. Has relatively high self-discharge needs recharging after storage

Solid State Batteries:
Compressed air tanks are more like capacitors, as the charge stored falls, the pressure (like the capacitor voltage) also falls. To be able to do a constant power output the air flow (electrical current) would have to be increasingly large instead of a more desirable constant current like a battery.
Nuclear Batteries:
High initial cost production as its in the experimental stage. Energy conversion technology is not much advanced. Regional and country specific laws regarding use and disposal of radioactive fuels. Still to gain social acceptance.

II. CONCLUSION

This Study provides an insight to the basic properties of different types of batteries and their respective uses to maximize the life span and quality of the device where they have been employed.

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