

CEEAMA E-NEWS

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Electrical Consultants' Newsletter

November 2018

From the Secretary's Desk



Hello!!!!

Welcome all back from the Diwali celebrations.

Now we all must work and concentrate on the CEEA-MATECH2019 exhibition.

All Governing council members are working for the same. I request all our members to send the

recommendation of the various vendors to be part of our exhibition.

CEEAMA has MoU with organizations like ECAM, FSAI for mutual benefits, and increasing awareness in our members about cross functionalities. All our members are requested to suggest more and more organizations to whom CEEAMA can connect for mutual benefits.

Now the time is ticking out. As requested, earlier CEEAMA needs good technical articles on electrical topics. I request all the members as well as well-wishers to write and send the same to CEEAMA. It will be published in CEEAMA-E-NEWS or in printed edition of CEEAMA NEWS at the time of exhibition.

We request all our members to indicate the way they can assist CEEAMA to grow. As a short term goal, you may assist by putting in all your efforts to make CEEAMATECH-2019 successful by helping CEEAMA GC by one of the above appeals.

Lot much can be done to promote and participate in our CEEA-MATECH-2019. I request all to do the same.

Thanks With warm regards,

Suhaskeskar

Hon. Secretary

CEEAMA

What is New?

IoT Smart Sensors Use Cloud for Low Power Motor Condition Monitoring

In earlier days maintenance of LV motor completely depends on operator/ maintenance personal and sometimes lead to motor failures due to unexpected issues in Motor. Even failure of small LV motor affects complete production which may leads to losses.

Condition monitoring, a technology that has been slowly moving forward for several years, is reaching toward its potential with new solutions for low voltage motors. Monitoring the operating condition of motors has obvious availability and productivity benefits, enabling a new level of preventive maintenance. But now the combination of compact sensors, cloud connectivity, and application software is creating a new level of operating data transparency.

The followings are the advantage of new system even though it includes additional cost to it.

- Identify inefficiencies within system
- Uncover potential for energy savings
- Reduce risks related to operation and maintenance
- Prevent unexpected downtime
- Cut maintenance costs
- Extend equipment lifetime

Recently, Siemens demonstrated a new IoT concept for its Simotics drive technology for monitoring the operating condition of low voltage motors using a connection to the MindSphere open IoT operating system. Using a compact sensor box to capture operating and condition parameters, and transmit them via WiFi to the cloud, operating data can then be analyzed by the Simotics IQ MindApp on MindSphere.

ABB also introduced its Ability™ Smart Sensor condition monitoring solution targeting low voltage motors. By monitoring and analyzing data on motor operating parameters, ABB claims this approach will enable motors to reduce downtime by as much as 70 percent, extend motor lifetimes by up to 30 percent and reduce energy consumption by up to 10%.



Source:

- 1) <https://www.designnews.com/automation-motion-control/iot-smart-sensors-use-cloud-low-power-motor-condition-monitoring/39780907258071>
- 2) <https://new.abb.com/motors-generators/service/advanced-services/smart-sensor>

Contributed By Mangesh Shirgaonkar

What is New? : IoT Smart Sensors Use Cloud for Low Power Motor Condition Monitoring

Article : Energy Storage Technologies for UPS Systems

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Article

Energy Storage Technologies for UPS Systems

1. Energy Storage

When electrical service is disrupted (i.e., a mains failure), the UPS continues to support the load connected to it through its energy storage system. The UPS may provide power for durations ranging from 10 to 20 seconds to several hours. Shorter duration UPSs are designed to:

- carry the load during the start-up of back-up electrical generators, typically diesel engine driven generators, and
- enable a smooth transition to the generator as the power source.

In many cases, the UPS is designed to provide power for five to 20 or perhaps 30 minutes. The purpose is to enable an orderly shutdown of operations – thereby avoiding an abrupt shutdown which would otherwise cause equipment damage, product/work losses or a security/safety hazard. The under-desk UPS for PCs is an example.

UPSs with enough energy to provide power for several hours are somewhat rare. A key reason is that, in most situations, it is less expensive to store energy in the form of diesel fuel (for generators) if power is needed for several to many hours. Grid-connected storage may be preferable if noise or air emissions are an issue or if diesel fuel cost is high.

There are different technologies of energy storage solution available in the market like

- Battery
- Flywheels
- Ultra capacitors

The selection of right energy storage system depends on

- Required Runtime/backup time
- Power density/Footprint
- Weight
- Lifespan / Cycle count
- Reliability
- Cost of Ownership (Initial cost /Maintenance cost)
- Operating temperature

2. Energy Storage system - Battery

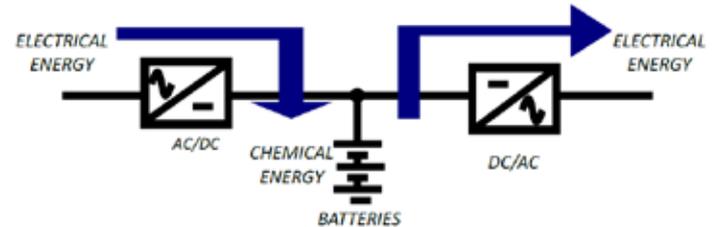
2.1. Types of Battery

Battery is the most critical component in the UPS and is also considered as heart of the UPS System, without battery the UPS is just a power conditioner. The purpose of the Battery is to provide the energy necessary to supply the load when the mains supply is not available. Cost of Battery is a major component on the final price of the UPS solution proposed to the customer.

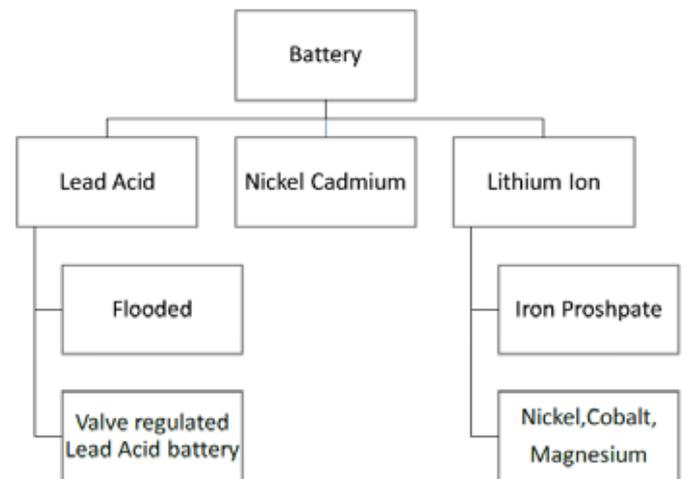
A battery is an electrochemical device that stores energy at one

time for use at another. The energy is stored in chemical form and converted to electrical form during discharge. The UPS battery may furnish power to the inverter for a few seconds, many minutes, or hours. The battery capacity is determined by the amount of power the inverter and its load require during that time.

There are basically three types of batteries



- Nickel Cadmium
- Lead Acid
- Lithium Ion Battery



2.1.1. Lead Acid Battery

The storage battery or secondary battery is such battery where electrical energy can be stored as chemical energy and this chemical energy is then converted to electrical energy as when required. The conversion of electrical energy into chemical energy by applying external electrical source is known as charging of battery. Whereas conversion of chemical energy into electrical energy for supplying the external load is known as discharging of secondary battery. During charging of battery, current is passed through it which causes some chemical changes inside the battery. This chemical change absorb energy during their formation.

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When the battery is connected to the load, the chemical changes take place in reverse direction, during which the absorbed energy is released as electrical energy and supplied to the load. Now we will try to understand principle working of lead acid battery and for that we will first discuss about lead acid battery which is very commonly used as storage battery or secondary battery.

The main active materials required to construct a lead acid battery are

- Lead peroxide (PbO₂).
- Sponge lead (Pb)
- Dilute sulfuric acid (H₂SO₄).

The positive plate is made of lead peroxide. This is dark brown, hard and brittle substance. The negative plate is made of pure lead in soft sponge condition. Dilute sulfuric acid used for lead acid battery has ration of water : acid = 3:1.

During Discharging

Both of the plates are covered with PbSO₄. Specific gravity of sulfuric acid solution falls due to formation of water during reaction at PbO₂ plate. As a result, the rate of reaction falls which implies the potential difference between the plates decreases during discharging process.

During Charging

Lead sulfate anode gets converted into lead peroxide. Lead sulfate of cathode is converted to pure lead. Terminal potential of the cell increases. Specific gravity of sulfuric acid increases.

The lead acid battery are further classified as

- Tubular/Flooded Battery
- Sealed maintenance Free VRLA Battery

SMF (Sealed Maintenance Free) battery is a battery which doesn't require topping up due to negligible water loss. It is designed in such a way that it cannot be opened or refilled. These batteries are safe, Maintenance free and are suitable for low end applications. The SMF battery will have an additional safety valve which release the excessive formation of hydrogen as a result of overcharging in to the atmosphere.

SMF battery works on a recombination technology where the hydrogen gas evolved during the charging process is converted to water with the help of oxygen present inside the battery container.

The typical performance of the battery is less and is limited to operating temperature, the charging profile. The SMF battery delivers higher power at higher temperatures but the life of battery comes down significantly. The SMF battery needs to be installed in a controlled environment to maintain the temperature at 25-27 deg C and an additional hydrogen sensor in the battery room is recommended for installation.

Tubular Batteries have openings at top to add distilled water for maintenance and safe running.

These batteries are very rugged and used in Cyclic application. These batteries last longer due to complex design and are suitable for high end applications.

The tubular battery can be installed in any environment (other than closed air conditioner room) with proper ventilation and air exchanges as hydrogen evolution from the battery is higher when compared with SMF battery.

Advantages

Inexpensive and simple to manufacture — in terms of cost per watt hours, the SLA is the least expensive.

Mature, reliable and well-understood technology — when used correctly, the SLA is durable and provides dependable service.

Low self-discharge — the self-discharge rate is among the lowest in rechargeable battery systems.

Low maintenance requirements — no memory; no electrolyte to fill.

Capable of high discharge rates.

Limitations

Cannot be stored in a discharged condition.

Low energy density — poor weight-to-energy density limits use to stationary and wheeled applications.

Allows only a limited number of full discharge cycles — well suited for standby applications that require only occasional deep discharges.

Environmentally unfriendly — the electrolyte and the lead content can cause environmental damage.

Transportation restrictions on flooded lead acid — there are environmental concerns regarding spillage in case of an accident.

Thermal runaway can occur with improper charging.

2.1.2. Nickel cadmium cell (NiCad)

The active components of a rechargeable NiCad battery in the charged state consist of nickel hydroxide (NiOOH) in the positive electrode and cadmium (Cd) in the negative electrode. For the electrolyte, usually caustic potash solution (potassium hydroxide) is used. Due to their low internal resistance and the very good current conducting properties, Ni-Cd cells can supply extremely high currents and can be recharged rapidly.

These cells are operating in a large temperature range, from +60°C down to -20°C. The selection of the separator (nylon or polypropylene) and the electrolyte (KOH, LiOH, NaOH) is also of great importance. These constituents influence the voltage conditions in the case of a high current discharge, the service life and the overcharging capability of the cell. In the case of misuse, a very high-pressure may arise quickly.

For this reason, these cells are equipped with a reversible safety valve, which can act several times. NiCad cells offer a long service life (depending on the type of application and charging unit up to 2000 cycles) thereby ensuring a high degree of the economy.

Advantages

Fast and simple charge — even after prolonged storage.

High number of charge/discharge cycles — if properly maintained, the NiCad provides over 1000 charge/discharge cycles.

Good load performance — the NiCad allows recharging at low temperatures.

Long shelf life — in any state-of-charge.

Simple storage and transportation — most airfreight companies accept the NiCad without special conditions.

Good low temperature performance.

Forgiving if abused — the NiCad is one of the most rugged rechargeable batteries.

Economically priced — the NiCad is the lowest cost battery in terms of cost per cycle.

Available in a wide range of sizes and performance options — most NiCad cells are cylindrical.

Limitations

Relatively low energy density — compared with newer systems.

Memory effect — the NiCad must periodically be exercised to prevent memory.

Environmentally unfriendly — the NiCad contains toxic metals. Some countries are limiting the use of the NiCad battery.

Has relatively high self-discharge — needs recharging after storage.

2.1.3. Lithium Ion battery

Lithium-ion batteries offer several advantages over traditional valve-regulated, lead acid batteries commonly used in UPSs today. A much longer life span, smaller size and weight, faster recharge times, and declining prices have made lithium-ion batteries an appealing energy storage technology

Similar to the lead- and nickel-based architecture, lithium-ion uses a cathode (positive electrode), an anode (negative electrode) and electrolyte as conductor. The cathode is a metal oxide and the anode consists of porous carbon. During discharge, the ions flow from the anode to the cathode through the electrolyte and separator; charge reverses the direction and the ions flow from the cathode to the anode.

When the cell charges and discharges, ions shuttle between cathode (positive electrode) and anode (negative electrode). On discharge, the anode undergoes oxidation, or loss of electrons, and the cathode sees a reduction, or a gain of electrons. Charge reverses the movement.

All materials in a battery possess a theoretical specific energy, and the key to high capacity and superior power delivery lies primarily in the cathode. For the last 10 years or so, the cathode has characterized the Li-ion battery.

Common cathode material is

- Lithium Cobalt Oxide (or Lithium Cobaltate),
- Lithium Manganese Oxide (also known as spinel or Lithium Manganate),
- Lithium Iron Phosphate,
- Lithium Nickel Manganese Cobalt (or NMC) and
- Lithium Nickel Cobalt Aluminum Oxide (orNCA)

Advantages

High energy density — potential for yet higher capacities.

Relatively low self-discharge — self-discharge is less than half that of NiCd and NiMH.

Low Maintenance — no periodic discharge is needed; no memory.

Limitations

Requires protection circuit — protection circuit limits voltage and current. Battery is safe if not provoked.

Subject to aging, even if not in use — storing the battery in a cool place and at 40 percent state-of-charge reduces the aging effect.

Moderate discharge current.

Subject to transportation regulations — shipment of larger quantities of Li-ion batteries may be subject to regulatory control. This restriction does not apply to personal carry-on batteries.

Expensive to manufacture — about 40 percent higher in cost than NiCd. Better manufacturing techniques and replacement of rare metals with lower cost alternatives will likely reduce the price.

Not fully mature — changes in metal and chemical combinations affect battery test results, especially with some quick test methods.

One of the major limitation of Lithium Ion battery is the requirement of Battery Monitoring system(BMS). The main purpose of the BMS is to protect the battery from

- Charge and discharge Control (to protect the batter from higher discharge current or charging current)
- Higher temperature
- Higher Voltage

The BMS can also be used for Cell balancing and also offers the other advantages of monitoring the performance of the battery.

2.1.3.1. Construction of Li-Ion Battery

Like any other battery, a rechargeable lithium-ion battery is made of one or more power generating compartments called cells. Each cell has essentially three components: a positive electrode (connected to the battery's positive or + terminal), a negative electrode (connected to the negative or – terminal), and a chemical called an electrolyte in between them. The positive electrode is typically made from a lithium based chemical compound).The negative electrode is generally made from carbon (graphite) and the electrolyte varies from one type of battery to another—but isn't too important in understanding the basic idea of how the battery works.

All lithium-ion batteries work in broadly the same way. When the battery is charging up, the positive electrode gives up some of its lithium ions, which move through the electrolyte to the negative, graphite electrode and remain there. The battery takes in and stores energy during this process. When the battery is discharging, the lithium ions move back across the electrolyte to the positive electrode, producing the energy that powers the battery. In both cases, electrons flow in the opposite direction to the ions around the outer circuit. Electrons do not flow through the electrolyte: it's effectively an insulating barrier, so far as electrons are concerned.

The movement of ions (through the electrolyte) and electrons (around the external circuit, in the opposite direction) are interconnected processes, and if either stops so does the other. If ions stop moving through the electrolyte because the battery completely discharges, electrons can't move through the outer circuit either—so you lose your power. Similarly, if you switch off whatever the battery is powering, the flow of electrons stops and so does the flow of ions. The battery essentially stops discharging at a high rate (but it does keep on discharging, at a very slow rate, even with the appliance disconnected).

Unlike simpler batteries, lithium-ion ones have built in electronic controllers that regulate how they charge and discharge. They prevent the overcharging and overheating that can cause lithium-ion batteries to explode in some circumstances.

2.1.3.2. Working Principle of Lithium Ion Battery

As their name suggests, lithium-ion batteries are all about the movement of lithium ions: the ions move one way when the battery charges (when it's absorbing power); they move the opposite way when the battery discharges (when it's supplying power):

During charging, lithium ions (yellow circles) flow from the positive electrode (red) to the negative electrode (blue) through the electrolyte (gray). Electrons also flow from the positive electrode to the negative electrode, but take the longer path around the outer circuit. The electrons and ions combine at the negative electrode and deposit lithium there.

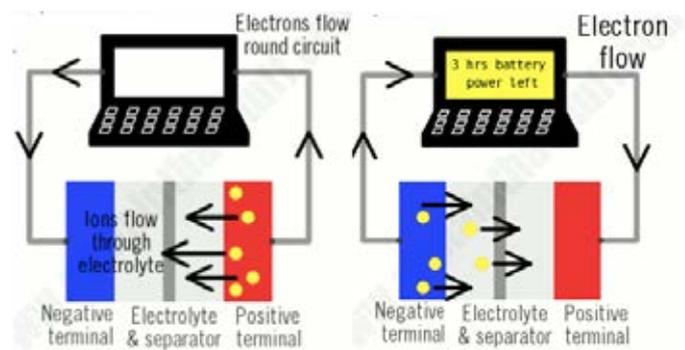


Figure 1 Charging of Li-Ion Battery

Figure 2 Discharging of Li-Ion Battery

When no more ions will flow, the battery is fully charged and ready to use.

During discharging, the ions flow back through the electrolyte

from the negative electrode to the positive electrode. Electrons flow from the negative electrode to the positive electrode through the outer circuit, powering your laptop. When the ions and electrons combine at the positive electrode, lithium is deposited there. When all the ions have moved back, the battery is fully discharged and needs charging up again.

2.1.3.3. Advantages Lithium Ion over Conventional Lead Acid Battery

2.1.3.3.1. Operating Temperature

Batteries do not like high temperatures, as they reduce service life. However, increased temperatures have a much larger impact on lead batteries than they do on lithium batteries. Temperatures above 25 Deg C reduce the lifetime of lead batteries rapidly, whereas lithium batteries tolerate temperatures up to 45 Deg C. When the temperature rises from 25 Deg C to 30°C, the service life of lead batteries (e.g. AGM/GEL) will shorten by a factor of 2.

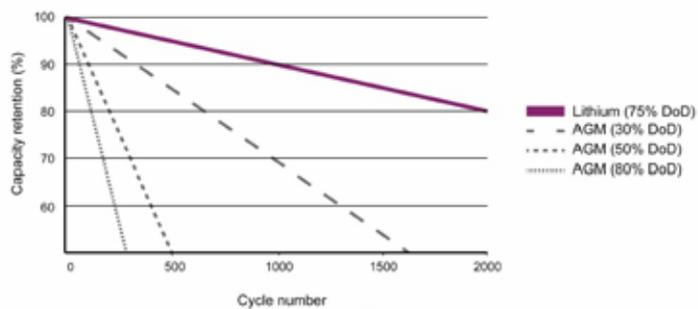


Figure 3 No of Cycles at 33 Deg C

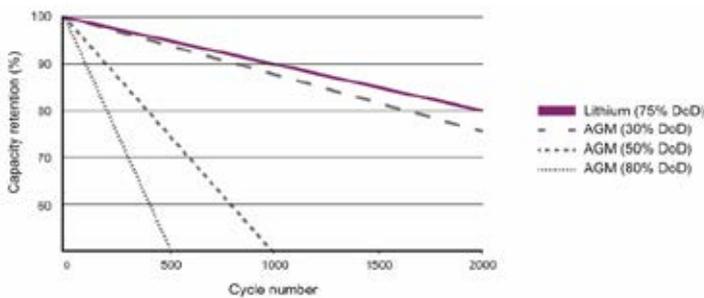


Figure 4 No of Cycles at 20 Deg C

It is evident from the above graphs the performance of Lithium Ion battery is superior even at high temperature of 33 Deg C. With the increase to 40 Deg C, the service life of lead batteries will decrease drastically and we might have to replace it in a year's time whereas with lithium-based battery technologies, temperatures of 40 Deg C do not have any significant impact on battery lifetime.

2.1.3.3.2. Depth of Discharge

The Depth of Discharge (DOD) relates to how deep you drain the battery in every cycle. The deeper you discharge the battery, the fewer discharge cycles it can make, thus the shorter the service life of the battery will be. Lithium batteries can be easily discharged up to 95% whereas lead batteries are limited to 50%. The graph below shows how the depth of discharge is related to the number of cycles for both lead batteries and lithium batteries.

If we want to use the batteries for around 2000 cycles (2000/365 days = 5,5 years), you can only discharge lead batteries between 25-35%, while for lithium this is around 80%. This means you need to have at least 4x the capacity of a lithium battery to get the same battery life for a lead battery! Or to put it otherwise: if you want to use 80% of a battery's capacity, you can only use a lead battery for 250-500 cycles versus 2000 cycles for a lithium battery. A lead battery will have to be replaced 4-8 times more often than lithium!

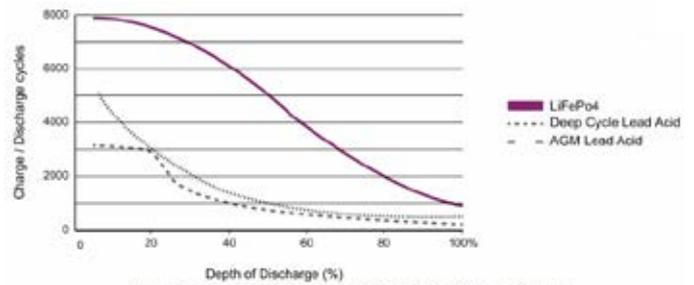


Figure 5 Battery Life Cycle based on DOD at 0.5C Discharge Current

2.1.3.3.3. Charging Characteristic of Battery

As illustrated below conventional Lead acid battery (figure 4) can be re-charged with a min of 0.1C and would take around 8hrs to reach 80% of its rated capacity and around 12hrs to reach its 100% rated capacity whereas Lithium Ion battery (figure 5) can be re-charged with a min of 0.5C and would take around 3hrs to reach 100% of its rated capacity.

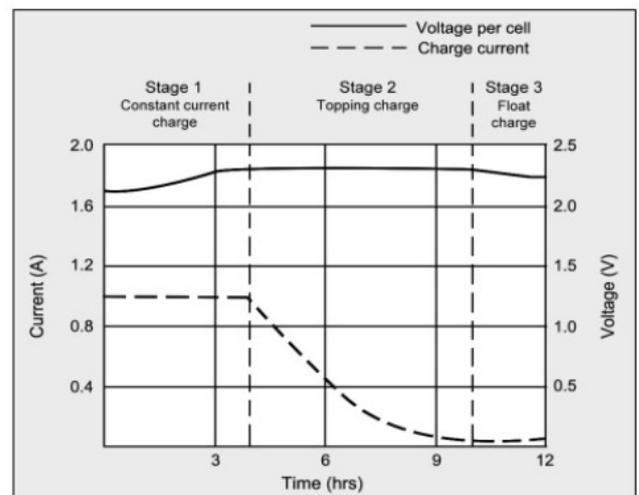


Figure 6 Charging Profile of Lead Acid Battery

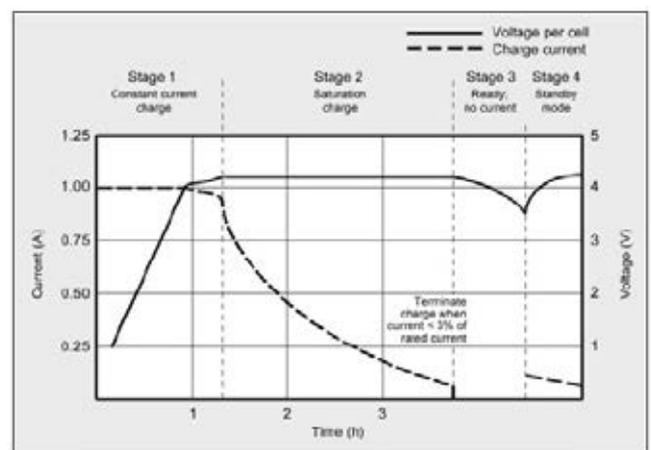


Figure 7 Charging Profile of Lithium Ion Battery

2.1.3.3.4. Reliability

Lead Acid Battery loses its capacity over a period of time primarily due to the corrosion of the positive plates. Typically end of Life of lead acid battery is considered as 80% and at 70% it starts to decline and loses its capacity rapidly and the failure mode is not predictable.

Lithium ion cells main ageing process is a steady thickening of a solid electrolyte film at the surface of active materials. This results in a steady, predictable loss of capacity and associated rise in internal resistance. If a cell has, for example, taken 10 years to reach 80% of original performance it will take another ten years, under the same conditions, to reach 60% of performance.

2.1.3.3.5. Generic Comparison of Lithium Ion and Lead Acid Battery

Specifications	Lead Acid	Lithium Ion Battery		
		Cobalt	Manganese	Phosphate
Specific Energy	30-50	150-250	100-150	90-120
Overcharge Tolerance	High	Low	Low	Low
Self-Discharge /Month	5%	<0.5%		
Cell Voltage	2V	3.6V	3.7V	3.2V
Size	Bulky	Compact	Compact	Compact
Safety Requirement	Thermally Stable	Protection Circuits are Mandatory		
Efficiency	~90%	~99%	~99%	~99%
Cost	Low	High		

2.1.3.3.6. Comparison of Different Types Li-Ion Battery

In principle, the battery used predominately for UPS applications is based on Lithium Iron

Phosphate: LiFePO4 cathode, graphite anode

Technology	Lithium Cobalt Oxide: LiCoO ₂ cathode (~60% Co), graphite anode	Lithium Manganese Oxide: LiMn ₂ O ₄ cathode. graphite anode	Lithium Iron Phosphate: LiFePO ₄ cathode, graphite anode	Lithium Nickel Manganese Cobalt Oxide: LiNiMnCoO ₂ . cathode, graphite anode	Lithium Nickel Cobalt Aluminum Oxide: LiNiCoAlO ₂ cathode (~9% Co), graphite anode
Voltages	3.60V nominal; typical operating range 3.0–4.2V/cell	3.70V (3.80V) nominal; typical operating range 3.0–4.2V/cell	3.20, 3.30V nominal; typical operating range 2.5–3.65V/cell	3.60V, 3.70V nominal; typical operating range 3.0–4.2V/cell, or higher	3.60V nominal; typical operating range 3.0–4.2V/cell
Specific energy (capacity)	150– 200 Wh/kg. Specialty cells provide up to 240Wh/kg.	100–150Wh/kg	90–120Wh/kg	150–220Wh/kg	200-260Wh/kg; 300Wh/kg predictable
Charge (C-rate)	0.7–1C, charges to 4.20V (most cells); 3h charge typical. Charge current above 1C shortens battery life.	0.7–1C typical, 3C maximum, charges to 4.20V (most cells)	1C typical, charges to 3.65V; 3h charge time typical	0.7–1C, charges to 4.20V, some go to 4.30V; 3h charge typical. Charge current above 1C shortens battery life.	0.7C, charges to 4.20V (most cells), 3h charge typical, fast charge possible with some cells
Discharge (C-rate)	1C; 2.50V cut off. Discharge	1C; 10C possible with some cells,	1C, 25C on some cells;	1C; 2C possible on some cells;	1C typical; 3.00V cut-off; high

	current above 1C shortens battery life.	30C pulse (5s) 2.50V cut-off	40A pulse (2s); 2.50V cut-off (lower than 2V causes damage)	2.50V cut-off	discharge rate shortens battery life
Cycle life	500–1000 related to depth of discharge load temperature	300–700 (related to depth of discharge temperature)	1000–2000 (related to depth of discharge temperature)	1000–2000 (related to depth of discharge temperature)	500 (related to depth of discharge temperature)
Thermal runaway	150°C (302°F). Full charge promotes thermal runaway	250°C (482°F) typical. High charge promotes thermal runaway	270°C (518°F) Very safe battery even if fully charged	210°C (410°F) typical. High charge promotes thermal runaway	150°C (302°F) typical High charge promotes thermal runaway
Application	Mobile phones tablets laptops cameras	Power tools medical devices electric power-trains	Portable and stationary needing high load currents and endurance	E-bikes medical devices EVs industrial	Medical devices industrial electric powertrain (Tesla)
Comments	Very high specific energy limited specific power. Cobalt is expensive. Serves as Energy Cell. Market share has stabilized.	High power but less capacity; safer than Lico-balt; commonly mixed with NMC to improve performance	Very flat voltage discharge curve but low capacity. One of safest Liions. Used for special markets. Elevated selfdischarge.	Provides high capacity and high power. Serves as Hybrid Cell. Favourite chemistry for many uses; market share is increasing.	Shares similarities with Li-cobalt. Serves as Energy Cell.

2.1.4. Energy Storage system - Flywheel

Flywheel stores electrical energy in the form of kinetic energy during charging process and during the discharging the kinetic energy is converted into potential energy.

A typical system consists of

- a rotor suspended by bearings inside a vacuum chamber to reduce friction, connected to a combination electric motor/electric generator.
- First generation flywheel energy storage systems use a large steel flywheel rotating on mechanical bearings. Newer systems use carbon-fiber composite rotors that have a higher tensile strength than steel and are an order of magnitude lighter.
- Magnetic bearings are necessary; in conventional mechanical bearings, friction is directly proportional to speed, and at such speeds, too much energy would be lost to friction.

The flywheel has a vacuum chamber on which a motor is held in a magnetic bearing. During charging process, the motor rotates at 1000rpm in clock wise direction to store the potential energy in the form of kinetic energy. During discharge the motor acts as a generator and will convert the kinetic energy back to potential energy

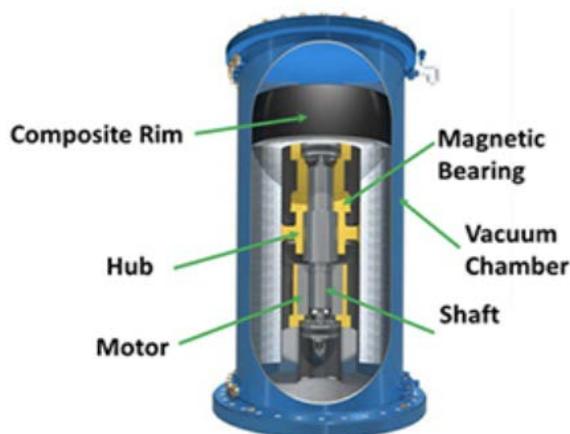


Figure 8 Structure of Flywheel

Advantages

- High energy density — potential for yet higher capacities.
- Low Maintenance — no periodic discharge is needed; no memory.
- Flywheels are not affected by temperature changes as are chemical rechargeable batteries
- Shorter time to recharge
- Long Life >20 years

Limitations

- Can be used only for a short backup time, in few seconds
- High power applications with shorter backup time

2.1.5. Energy Storage system – Super Capacitors

Super Caps (also known as ultracapacitors or electric double-layer capacitors) provide an alternative source of DC power to traditional rechargeable batteries. Supercapacitors are high density energy storage devices with a capacitance (energy density) of up to 10,000 times that of conventional electrolytic capacitors.

Supercapacitors or double layer capacitor store energy much in the same way as a conventional capacitor, hence the amount of stored energy can be described by: A double layer capacitor consists of two electrodes, a separator, electrolyte, two current collectors and housing.

A very high capacitance is obtained in this way. Super capacitors are suitable for high power applications and offer very quick response times and high efficiency. Disadvantages are comparatively low energy density, high self-discharge and high cost. Small units exist, larger is under development. Typical power ratings are 1kW-250 kW and efficiencies in the ranges of 85-98%

Advantages :

- Short duration runtime critical applications
- Compact foot print and power density
- High working ambient temperatures
- ECO friendly low environmental impact
- High energy efficiency and low running costs
- Lower Total Cost of Ownership (TCO)

Limitations :

- High self-discharge
- Ride through for shorter power outages

Contributed By Vinayak Vaidya Article by Consul Neowatt





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