Product Knowledge Document

Lead Acid Battery

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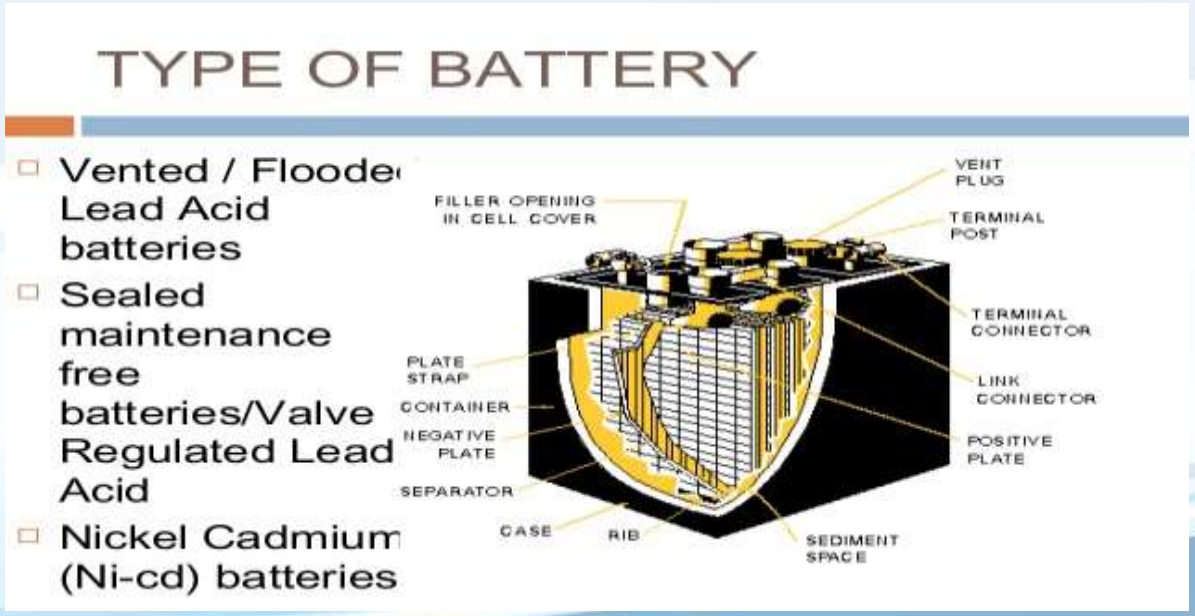
INTRODUCTION

The **lead–acid battery** was invented in 1859 by French physicist Gaston Planté and is the oldest type of rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, its ability to supply high surge currents means that the cells have a relatively large power-to-weight ratio. These features, along with their low cost, make them attractive for use in motor vehicles to provide the high current required by automobile starter motors.

As they are inexpensive compared to newer technologies, lead–acid batteries are widely used even when surge current is not important and other designs could provide higher energy densities. Large-format lead–acid designs are widely used for storage in backup power supplies in cell phone towers, high-availability settings like hospitals, and stand-alone power systems



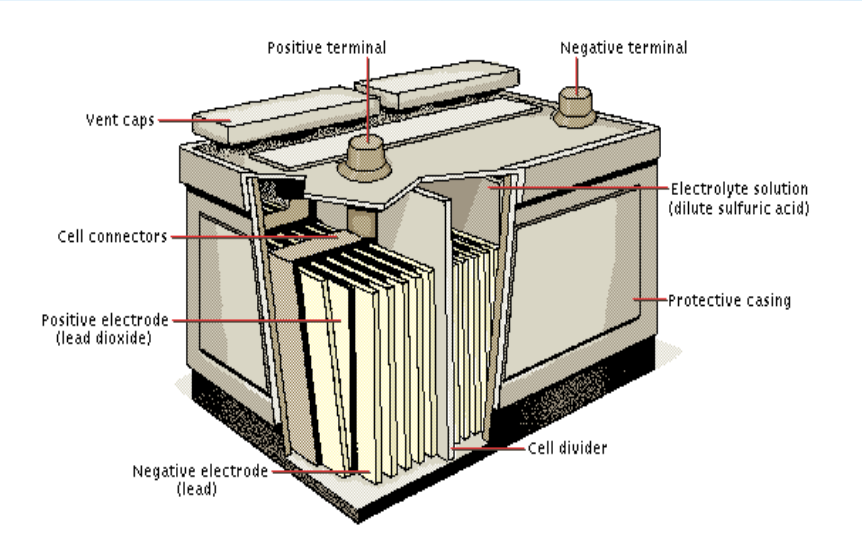
INDIAN STANDARDS FOR LEAD ACID BATTERY

The below mentioned are the Standards applicable for Lead Acid Battery –

1. **IS 1145 : 1980 Lead-acid storage batteries for motor cycle, auto-rickshaws and similar vehicles (second revision)**
2. **IS 1651 : 1991 Stationary cells and batteries, lead-acid type with tubular positive plates (second revision) 1652 : 1991 Stationary cells and batteries, lead-acid type with plates positive plates (third revision)**
3. **IS 6848 : 1979 Lead acid batteries for train lighting and air-conditioning services (first revision)**
4. **IS 7372 : 1995 Lead-acid storage batteries for motor vehicles (first revision) 7624 : 1990 Lead-acid starter batteries for diesel locomotives and rail cars**
5. **IS 7660 : 1988 Lead-acid batteries for electric locomotives and electrical multiple units (first revision)**

LEAD ACID BATTERY WORKING

Lead-Acid Battery Reaction



- **Anode: Porous lead**
- **Cathode: Lead-dioxide**
- **Electrolyte: Sulfuric acid, 6 molar H_2SO_4**
- **Discharging**
  (+) electrode: PbO2(s) + 4H+(aq) + SO4(2)-(aq) + 2e- → PbSo4(s) + 2H2O(l)
  (-) electrode: Pb(s) + SO42-(aq) → PbSO4(s) + 2e-
- **During charging**
  (+) electrode: PbSO4(s) + 2H2O(l) → PbO2(s) + 4H+(aq) + SO42-(aq) + 2e-
  (-) electrode: PbSO4(s) + 2e- → Pb(s) + SO42-(aq)

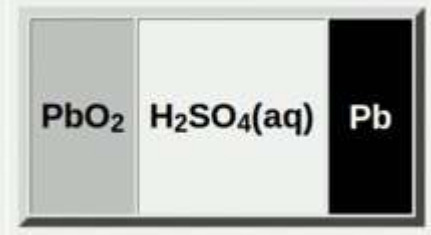
*** Pb02 – Lead diOxide , H – Hydrgen , So4 (2)- Sulfate , PbSo4 – Lead Sulfate, H2O - Water**

Basic Working Principle

- **Discharge Condition :-**In the discharged state both the positive and negative plates become lead(II) sulfate and the electrolyte loses much of its dissolved sulfuric acid and becomes primarily water.
- The discharge process is driven by the conduction of electrons from the negative plate back into the cell at the positive plate in the external circuit.

Basic Working Principle

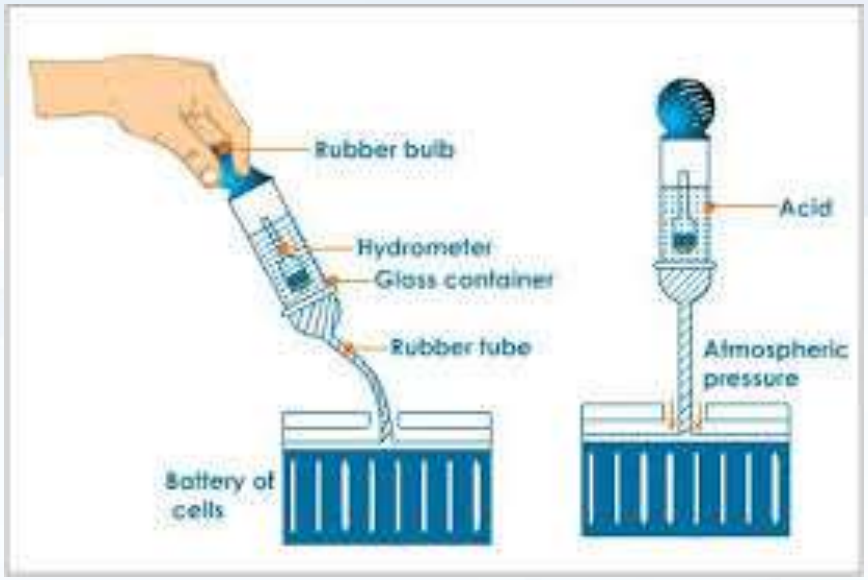
- **Charging Condition:-**Fully recharged: Lead anode, Lead oxide cathode and sulfuric acid electrolyte
- In the fully charged state, the negative plate consists of lead, and the positive plate lead dioxide, with the electrolyte of concentrated sulfuric acid.
- Overcharging with high charging voltages generates oxygen and hydrogen gas by electrolysis of water, which is lost to the cell. The design of some types of lead-acid battery allow the electrolyte level to be inspected and topped up with any water that has been lost.
- Due to the freezing-point depression of the electrolyte, as the battery discharges and the concentration of sulfuric acid decreases, the electrolyte is more likely to freeze during winter weather when discharged.



Measuring the Charged Level

Measuring Charged Level

- As electrolyte takes part in the charge-discharge reaction, this battery has one major advantage over other chemistries. It is relatively simple to determine the state of charge by merely measuring the specific gravity of the electrolyte; the specific gravity falls as the battery discharges. Some battery designs include a simple hydrometer using colored floating balls of differing density. When used in diesel-electric submarines, the specific gravity was regularly measured and written on a blackboard in the control room to indicate how much longer the boat could remain submerged.



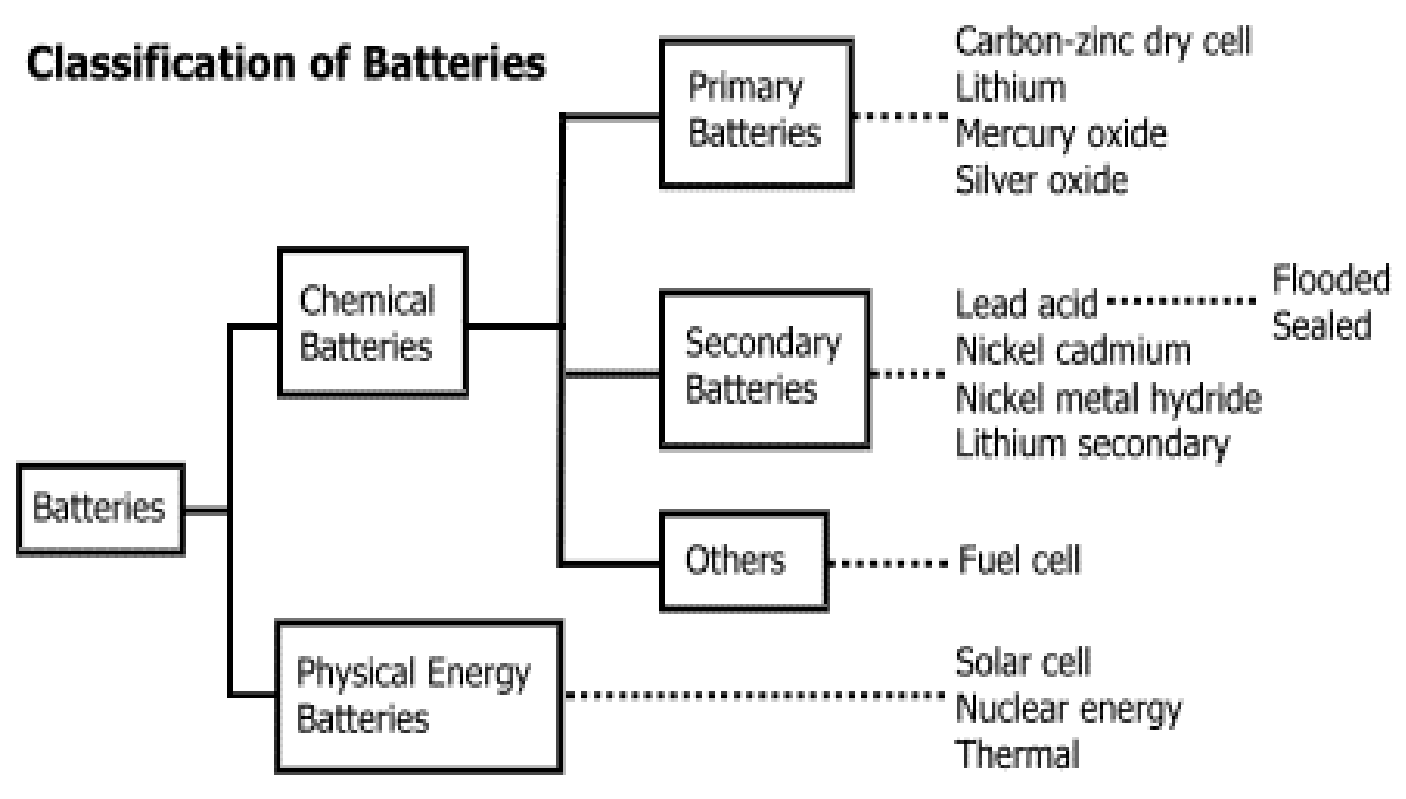
Measuring Charged Level

- The battery's open-circuit voltage can also be used to gauge the state of charge. If the connections to the individual cells are accessible, then the state of charge of each cell can be determined which can provide a guide as to the state of health of the battery as a whole, otherwise the overall battery voltage may be assessed.

- Note that neither technique gives any indication of charge capacity, only charge level. Charge capacity of any rechargeable battery will decline with age and usage, meaning that it may no longer be fit for purpose even when nominally fully charged. Other tests, usually involving current drain, are used to determine the residual charge capacity of a battery.

Classification of Batteries

Batteries Classification



Types of Batteries

Flooded Lead Acid Batteries

- Flooded Lead Acid batteries are the most commonly found lead acid battery type and are widely used in the automotive industry. They provide the most cost effective solution, as the least cost per amp hour, of any lead acid battery type.
- The modern wet cell comes in two styles; serviceable and maintenance free. Normal flooded batteries require extra care and regular maintenance in the form of watering, equalizing charges and keeping the terminals clean. Flooded cells need to be mounted the right way up and can be susceptible to spillage.
- Transporting Flooded Lead Acid Batteries brings with it its own challenges. Classified as a 'dangerous good', flooded lead acid batteries require very specific transportation methods and can only be shipped with accredited dangerous good certified shipping and courier companies.

Types of Batteries

Sealed Lead Acid Batteries

- Commonly known as Valve Regulated Lead Acid (VRLA) or Sealed Lead Acid (SLA). SLA batteries are available in a few different formats. Their principal manufacturing process, including number of plates and plate thickness determines its designated end user application. SLA batteries tend not to sulphate or degrade as easily as wet cells and are regarded the safest lead acid battery to use.
- Two main versions of Sealed Lead Acid Batteries (SLA) are commonly found. AGM (Absorbed Glass Matt) and Gel Cell (gelified electrolyte)

Types of Batteries

AGM Sealed Lead Acid Battery

- AGM batteries offer the best price point in the Valve Regulated Sealed lead acid variety. AGM Sealed Lead Acid Batteries utilise an Absorbed Glass Matt (AGM) process which is superior to traditional flooded technology. Fine, highly porous, micro-fiber glass separators absorb the electrolyte, increasing efficiency by lowering internal resistance, which in turn boosts capacity. Lower internal resistance also means that the battery can be recharged much faster than conventional flooded or wet lead acid batteries. AGM batteries provide much larger capacity in a smaller case size and are able to be mounted on their side and shipped using standard shipping processes.

  AGM batteries are found in many applications and are commonly used in; UPS, alarm and telecommunications industries, golf carts and trundlers, mobility vehicles, performance automotive and much more. As always, it is important to ensure you are selecting the right AGM battery for your application. Although the voltage, capacity, dimensions and ratings may be very similar across a range, each AGM battery has a specific application that they should be used in

Types of Batteries

Gel Sealed Lead Acid Types

- A common misconception is that all "sealed" lead acid batteries are GEL. Gel VRLA batteries contain a gelified electrolyte which differs to their AGM counterparts. Sulfuric acid is mixed with silica fume, which makes the resulting mass gel-like and immobile. This creates a completely maintenance free, non spill able lead acid battery product. Unlike a flooded or wet-cell lead acid battery, GEL cell batteries do not need to be kept upright and can be shipped using standard shipping process'.
- GEL's inherit design reduces electrolyte evaporation, spillage and subsequent corrosion issues that are very common in flooded or wet-cell batteries. GEL batteries boast greater resistance to extreme temperatures, shock, and vibration. They are capable of withstanding over discharging, which typically causes irreversible damage to Flooded and some AGM batteries. They are ideal in applications where a constant current is required such as golf carts, mobility, power bank and RV power bank applications. GEL are generally much more expensive than their AGM and Flooded counterparts. They have a very low discharge rate (1% per month), but they require specific charging practices and need to be charged with a GEL specific battery charger.

Types of Batteries

Deep Cycle Lead Acid Batteries

- Deep Cycle Sealed Lead Acid batteries, as the name suggests, are specifically designed for deep cycling applications. They contain fewer plates than their cranking or starting counterparts. These plates are also much thicker. This reduces the total surface area, resulting in a battery that provides lower max current, but is capable of a much deeper state of charge.
- Deep cycle batteries are typically discharged to 50% of their capacity and recharged again. This is known as the depth of discharge (DoD). This level of cycling is generally used in applications where the battery is providing constant current for long periods of time. Such as golf carts, mobility scooters, power banks, RV power banks, Solar energy systems etc.
- The basic formula that we follow when recommending a deep cycle battery is to suggest one with a residual capacity approximately three times the estimated daily use. It is recommended to bring Deep Cycle batteries back up to full charge every few months to maintain their levels true capacity. Failure to do so will reduce the batteries life and over time it will provide lower and lower capacity. Deep Cycle Lead Acid Batteries are usually catagorised by their amp hour rating (AHr). Amp Hour is a measure of the batteries capacity.

Types of Batteries

Cranking or Engine Starting Lead Acid Batteries

- Engine Start batteries have a larger number of thinner plates. The total current output is affected by the total surface area. With thinner plates per battery, the end result is an increased surface area that will provide a much higher current potential.
- Generally Cranking batteries differ to their deep cycle counterparts as they have been specifically designed to produce a large burst of current in a short time frame. This is particularly useful in engine starting applications. Cranking batteries are generally catagorised based on their ccA (Cold Cranking Amps) rating. Cold Cranking Amps is a measure of the total current a fully charged battery at -18 degrees celsius can provide for 30 seconds, without dropping below 1.2v per cell (7.2v for a 12v battery). Typically this is 1% of the battery's capacity. The larger the ccA rating, the larger the engine the battery can turn over.
- Cranking batteries are not designed to be deep cycled or discharged. They are designed to turn over an engine and sit on float charge which is provided by the vehicles alternator. Discharging a cranking battery will start causing irreversible damage to the battery plates. This will ultimately reduce its performance, total life span and in some cases cause complete failure

Types of Batteries

Best of Both Worlds

- Known by a few different names, but most commonly as Hybrid. These batteries are designed for both engine starting and deep cycling. This is particularly useful in marine and RV applications where a large cracking current is required to start an engine, as well as cyclic ability to power on board devices and appliances.

Standby Lead Acid Batteries

- Standby Sealed Lead Acid batteries are the most basic variety of the Sealed Lead Acid range. As the name suggests, they have been designed only for standby applications where they operate on a float (very low) load, maintaining Uninterrupted Power Supplies (UPS), Alarm Systems, Telecommunications and Network Systems. Standby batteries are generally of AGM variety.

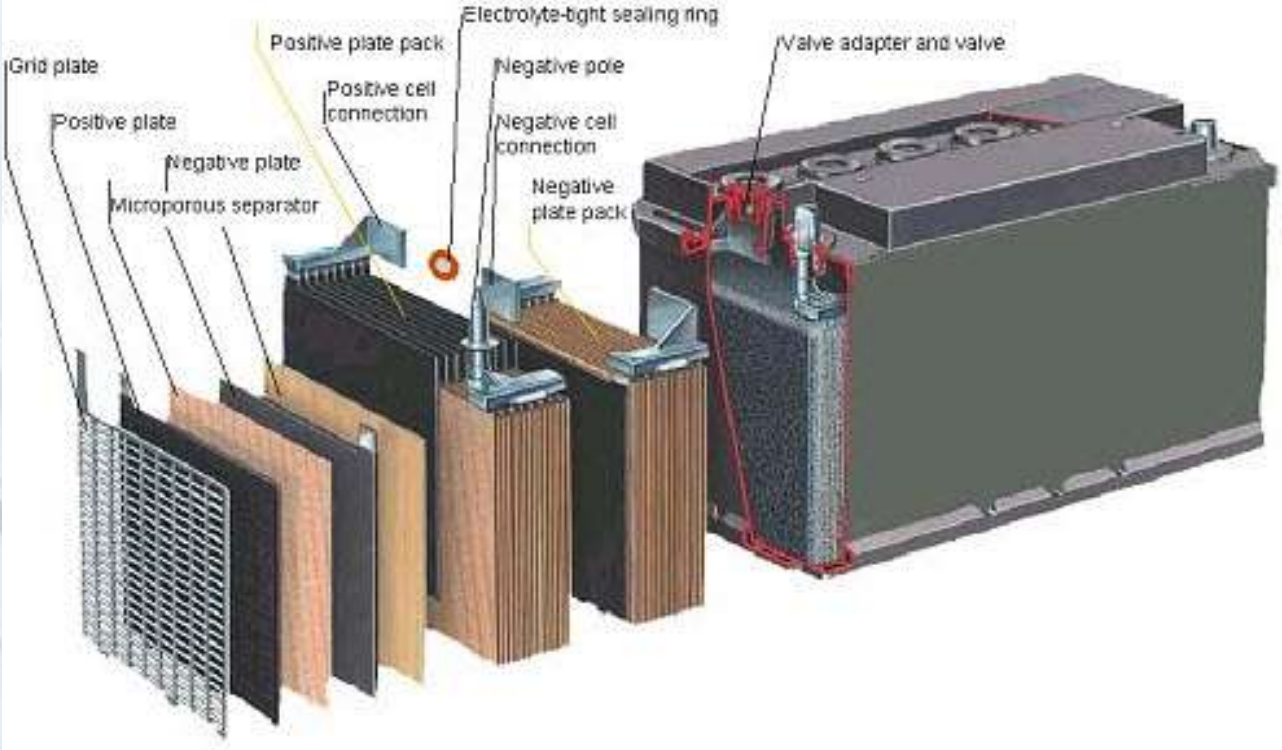
Types of Batteries

Marine Specific Batteries

- A marine battery can be cranking, deep cycle or a combination of both. The critical factor that allows this battery to be used in marine application is its construction process
- Marine conditions place a lot of stress and excessive vibration on a battery. Using a standard deep cycle and/or cranking battery for this application will produce normal results in the short term. However, in the long term, harsh marine conditions, excessive vibration and wear will damage the delicate lead acid battery, ultimately resulting in a battery that has lasted considerably less than its manufacturer rated lifespan. Batteries that are designed for marine will be specifically labeled as Marine Grade. Ask your retailer if the battery you are buying is designed to be used in marine conditions.

Construction of Lead Acid Batteries

BOM Details



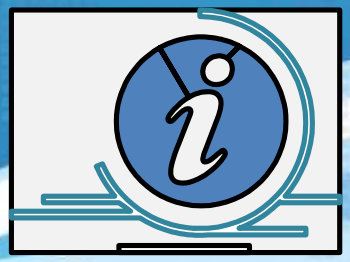
Advantages & Disadvantages

Lead-Acid Battery

- ***Advantages:***
  - Batteries of all shapes and sizes, available in
  - Maintenance-free products and mass-produced
  - Best value for power and energy per kilowatt-hour
  - Have the longest life cycle and a large environmental advantage
  - Ninety-seven percent of the lead is recycled and reused in new batteries

- ***Disadvantages***:
  - Lead is heavier compared to alternative elements
  - Certain efficiencies in current conductors and other advances continue to improve on the power density of a lead-acid battery's design

THANK YOU



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Are there any Questions?