

**MODULE -V**  
**ENERGY SOURCES & STORAGE DEVICES**

**5.4 Batteries**

**5.4.1 Alkaline Batteries**

**5.4.2 Lead-Acid Battery (or) Lead Storage Battery**

**5.4.3 Lithium battery**



## 5.4 Batteries

### Definition

Battery is an arrangement of several electrochemical cells connected in series that can be used as a source of direct electric current.

A cell contains one anode and cathode

A battery contains several anodes and cathodes,

### Types of batteries

- 1 Primary battery ( or) Primary Cells ( or) Non- reversible Battery
- 2 Secondary battery ( or) Secondary Cells ( or) Reversible battery
- 3 Flow Battery (or) fuel cells

#### 1 Primary Battery

The electrodes reactions cannot be reversed by passing external electrical energy They are not chargeable.

(eg) dry cell

#### 2 secondary Battery (Accumulator)

The electrode reactions can be reversed by passing external electrical energy .They are chargeable and are used again and again. They are called accumulators or storage cells.

(eg) Lead –Acid storage

Nickel- Cadmium Cell

#### 3. Flow battery or Fuel Cell

They cells in which reactants products and electrolyte pass through the cell continuously are called fuel cell or flow battery.

Here chemical energy is converted to electrical energy with combustion.

(eg) H<sub>2</sub>- O<sub>2</sub> fuel cell

### 5.4.1 Alkaline Batteries

Alkaline battery is an improved form of dry cell. It is an example for primary battery.

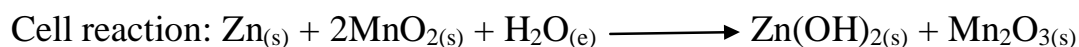
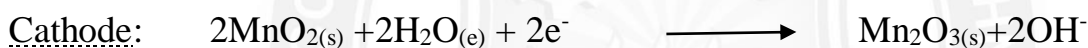
#### Description

Anode is Zinc (Zn)

Cathode is Manganese Dioxide (  $\text{MnO}_2$  )

Electrolyte is Potassium Hydroxide ( KOH )

#### Cell Reaction;



#### Advantages;

- 1) The emf of this cell is 1.5V
- 2) Zinc does not dissolve in basic medium ,so no corrosion occurs
- 3) If maintain its voltage as current is drain from it.
- 4) If performance better in cold weather that other types of batteries

#### Uses

It is used in calculator.

### 5.4.2 Lead-Acid Battery (or) Lead Storage Battery

- ❖ It is a 2<sup>o</sup> battery
- ❖ It can act as Voltaic cell and electrolyte cell
- ❖ During discharging – voltaic cell

❖ Recharging –electrolyte cell

**Diagram**

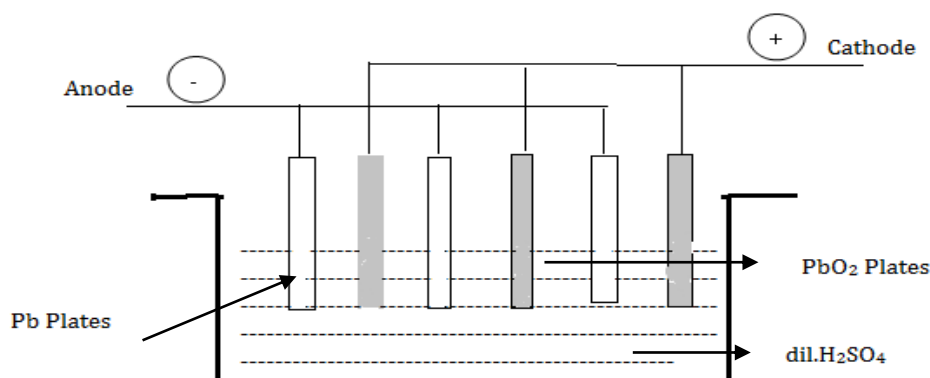


Fig:1-Lead acid storage battery

Source: physical chemistry by Arun paul

**Description**

Anode – Pb plates

Cathode – PbO<sub>2</sub> plates

Electrolyte – dil.H<sub>2</sub>SO<sub>4</sub>

- ❖ The electrodes are arranged in alternate pattern.
- ❖ The electrodes are separated by insulators like rubber wood etc.
- ❖ Single cell produces 2v.

Working:- Cell Representation:



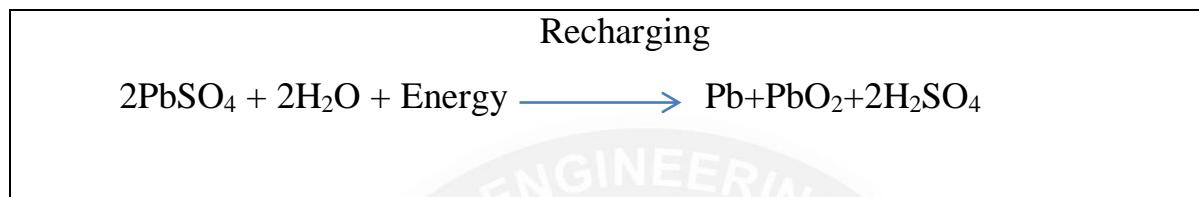
**1) Discharging**



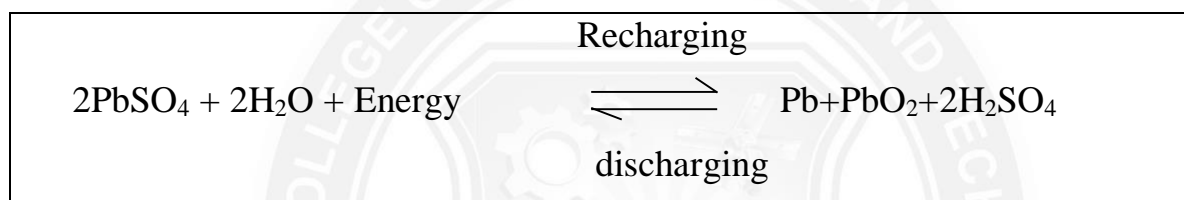
The formation of PbSO<sub>4</sub> shows that H<sub>2</sub>SO<sub>4</sub> is being used up

**Recharging**

- ❖ For recharging electric current is passed in the opposite direction.
- ❖ During recharging Pb deposits on anode, PbO<sub>2</sub> on cathode and concentration of H<sub>2</sub>SO<sub>4</sub> increased.



Both discharging and recharging reactions can be shown as,

**Uses**

- 1) It is used in cars , buses ,trucks etc,
- 2) It is also used in telephone exchanges , hospitals, power stations.

**5.4.3 Lithium battery**

- ❖ It is solid state battery.
- ❖ It can be recharged .
- ❖ The electrolyte is in solid state
- ❖ Produces a voltage of 3v.

**Construction**

Cathode : Lithium metal oxide (lithium-cobalt oxide (LiCoO<sub>2</sub>))

Anode : Lithium carbon compounds

Electrolyte - Polymer packed between two electrodes.

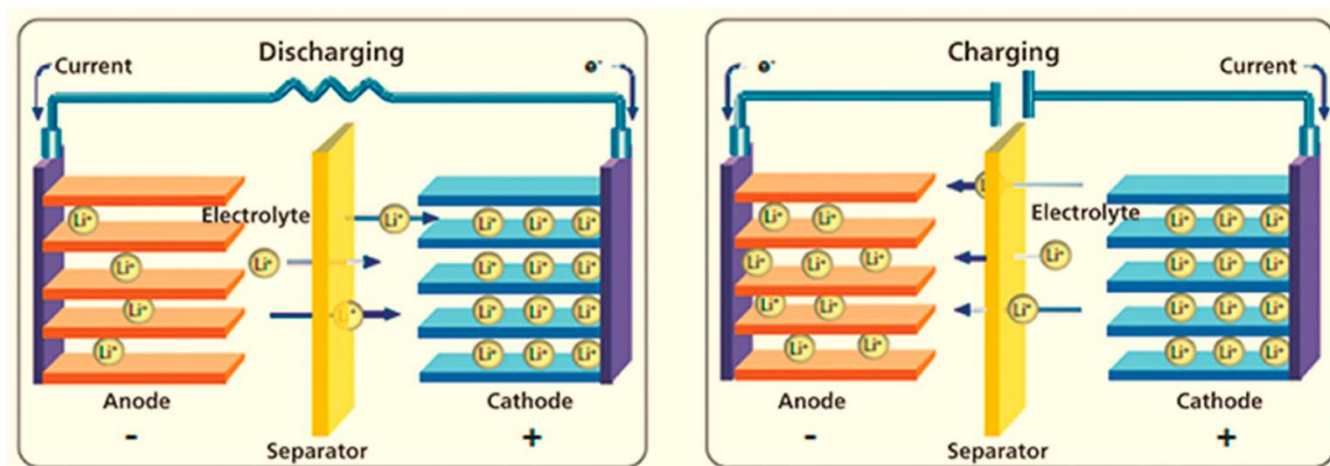


Fig:2-Li-ion battery

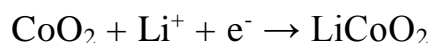
Source: Online sources

### Working

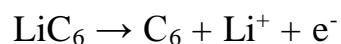
While the battery is discharging and providing an electric current, the anode releases lithium ions to the cathode, generating a flow of electrons from one side to the other. When plugging in the device, the opposite reaction happens, the cathode releases lithium ions and anode receives them. This is how the Lithium-ion battery works. Energy is stored and released as lithium ions travel between these electrodes through the electrolyte.

Inside a lithium-ion battery, oxidation-reduction (Redox) reactions take place.

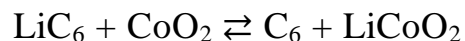
**Reduction** takes place at the cathode. There, cobalt oxide combines with lithium ions to form lithium-cobalt oxide ( $\text{LiCoO}_2$ ). The half-reaction is:



**Oxidation** takes place at the anode. There, the graphite intercalation compound  $\text{LiC}_6$  forms graphite ( $\text{C}_6$ ) and lithium ions. The half-reaction is:



Here is the full reaction (left to right = discharging, right to left = charging):



### Advantages (or) Reason for Lithium battery Called as cell of future

- a) High voltage of 3v is got.
- b) No leakage, as all constituents are solids.
- c) Weight of battery is low (Li is light weight metal).
- d) Battery can be made in variety of shapes and sizes.
- e) Low rate of discharge.

### Disadvantages

- Protection required
- High cost
- Flammable

### **Applications**

- Used in cameras, calculators and cardiac pacemakers
- Used to operate laptop computers, mobile phones and aero space applications.
- Used in many electrical tools and vehicles.