BATTERIES:

Battery is an electrochemical cell, which converts chemical energy to electrical energy is called Battery. Battery is a term usually applied to a group of two or more electric cells, connected together in series.

Advantages of Batteries:

1. Batteries acts as a Potable source of electrical energy.
2. Electronic equipments in the form of handsets has been made possible by batteries.
3. For all commercial applications, batteries are used

   Example: Automotives and aircrafts, Standby batteries etc.

Requirements of battery:

1. High capacity, which is very small variation of voltage during discharge.
2. High efficiency in energy

$$\% \text{ of efficiency} = \frac{\text{energy released on discharge}}{\text{energy required for charge}} \times 100$$

3. Long shelf life is required

4. Tolerance to different service conditions such as Variation in temperature, vibration shock etc.

Batteries are classified into three types.

1. Primary Battery

cell reaction is not reversible. The reactions occur only once and after they become dead. so they are not recharged.

example: Dry cell, mercury cell.

2. Secondary Battery:

cell reactions can be reversed and can be recharged. they can used again and again by recharging the cell.

example: Lead acid storage cell. Ni-cd cell.

3. Fuel cell:

In these, the reactants, products and electrolytes are continously passing through the cell. They do not store energy and cannot be reused

example: H_2O_2 fuel cell, methanol oxygen fuel cell.

Reserve battery:

It is also called as stand-by battery. is a primary battery, where part is isolated until the battery needs to be used.

→ Since the active chemicals of the cells are segregated until needed, thus reducing self discharge

→ A reserve battery is distinguished from a backup battery, it is inert until is activated

→ while a backup battery is already functional even if it is not delivering current.

Example: Radiosondes, fuzes, missiles, torpedoes and other weapon system.

→ Reserve batteries can be activated by the

i) addition of water
ii) addition of electrolyte
iii) addition of gas.

Zn- Air Battery:

Zn- air battery is a primary battery which is non- rechargeable and have high energy density.

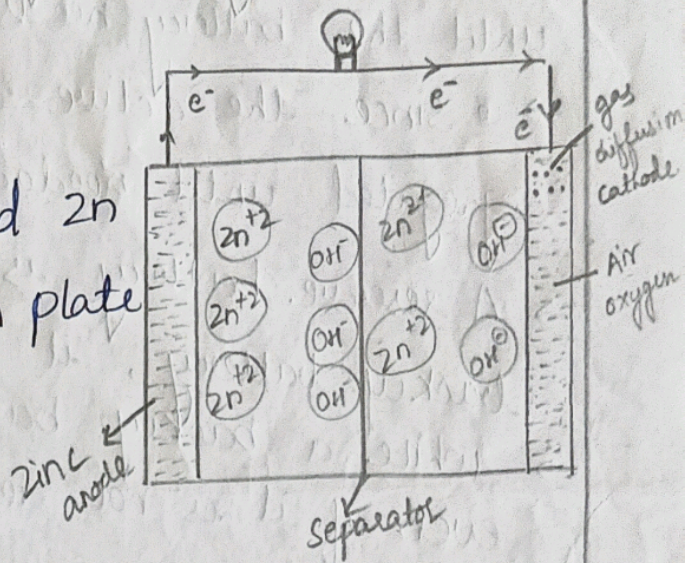
Construction:

Anode: Loose granulated Zn

cathode: Porous carbon plate

Electrolyte: KOH.

E.M.F : 1.4 V



Cell Reactions

At anode: $Zn + 2OH^- \longrightarrow ZnO + H_2O + 2e^-$

At cathode: $\frac{1}{2}O_2 + H_2O + 2e^- \longrightarrow 2OH^-$

over all Reaction $Zn + \frac{1}{2}O_2 \longrightarrow ZnO$.

when air passes through the cell, Zn is oxidised to ZnO at the anode during the discharge. Anode & cathode are separated by polyethylene.

Application:

1. It is used in power source in hearing aid. Size of batton
2. used in military radio recievers.
3. voice transmitters.

Zn-Air Batteries:

Lithium-ion batteries:

Lithium ion battery is a secondary battery As the name suggest, the movement of lithium ions are responsible for charging & discharging.

Anode: Layers of porous carbon (-ve electrode)

Cathode: Layers of Lithium-metal oxide (+ve electrode)

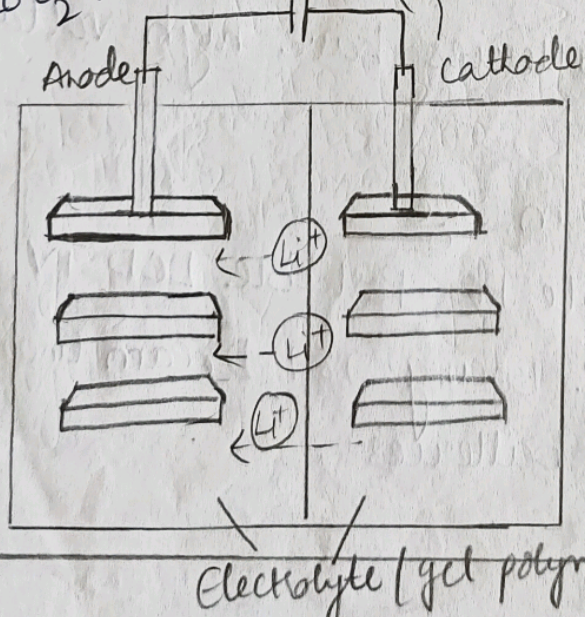
Electrolyte: Polymer gel (separator)
$LiPF_6$ & $LiClO_4$
Lithium hexa fluorophosphate of lithium perchlorate.

Working:

During charging Li^+ ions flows from positive electrode to negative electrode through electrolyte. Electrons also flow from positive to negative electrode

→ The electrons and Li^+ ions combines at the negative electrode and deposit as Li.

$$LiCoO_2 + C \longrightarrow Li_{1-x}CoO_2 + CLi_x$$

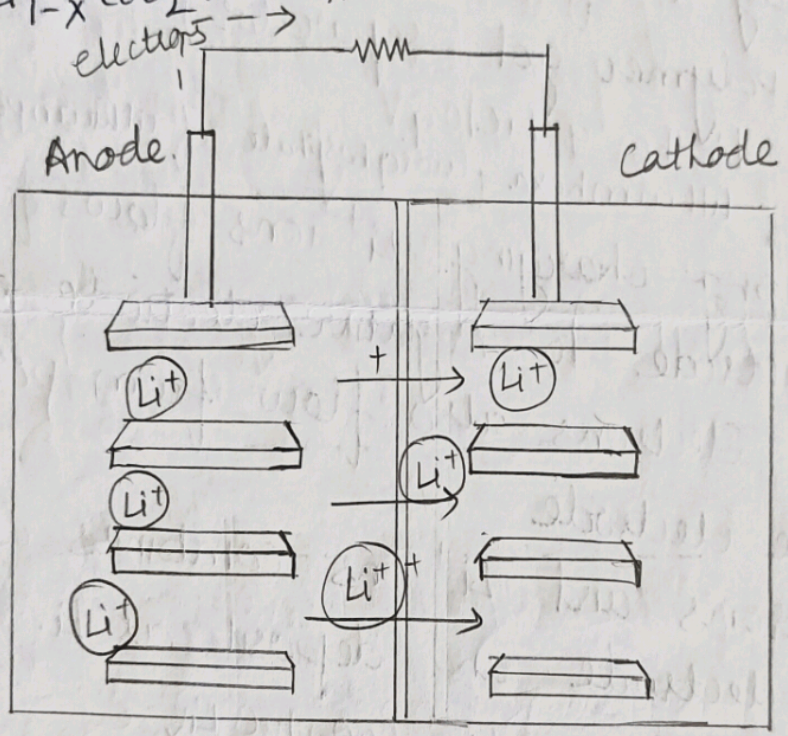


During discharging, the Li^+ ions flow back through the electrolyte from negative electrode to positive electrode.

→ Electrons flow from negative electrode to the positive electrode.

→ Li^+ ions & electrons combine at the positive electrode and deposit as Li.

$$Li_{1-x}CoO_2 + CLi_x \longrightarrow LiCoO_2 + C$$



Applications:

1. Lithium ion batteries have high voltage and light weight
2. It is smaller in size
3. cell phone, note PC, Portable LCD TV,
4. Air crafts like Boeing 787 Dream Liner make use of these batteries.

Hydrogen-oxygen Fuel cell:

Hydrogen-oxygen fuel cell, the oxidiser-oxygen and the liquid electrolyte are continously passed through the cell.

→ It consists of two porous electrode anode and cathode.

→ These porous electrodes are made of carbon. containing a small amount of catalyst (Pt, Pd, Ag)

→ Electrolytic solution 25% KOH. or NaOH. The two electrodes are connected through the voltmeter.

At Anode: Hydrogen gas is passed, it oxidised with the liberation of electrons which then combines with hydroxide ions to form water.

At Cathode: The electrons produced at the anode, pass through the external wire to the cathode where it is absorbed by oxygen and water to produce hydroxide ions.

At Anode: $2H_2(g) + 4OH^- \longrightarrow 4H_2O + 4e^-$

At cathode: $O_2(g) + 2H_2O + 4e^- \longrightarrow 4OH^-$

Net Reaction: $2H_2(g) + O_2 \longrightarrow 2H_2O$

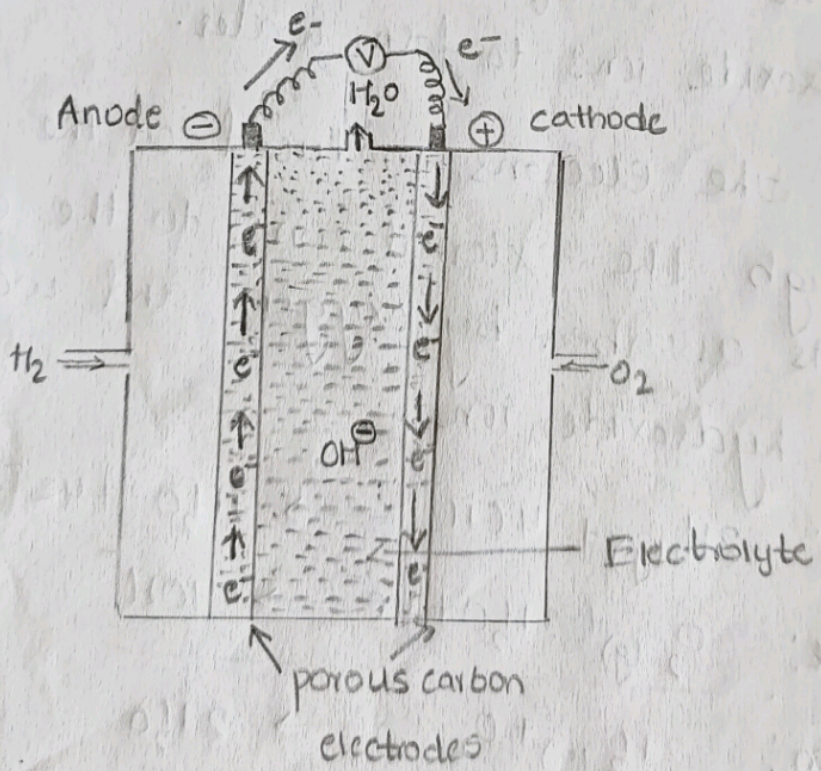
→ The standard emf of the cell $\epsilon^\circ = 1.23$ volts.

Application:

1. They are used as auxillary energy source in space vehicle, submarines or other military vehicles.
2. Because of light weight these fuel cells are preferred for space crafts and product H_2O is a valuable fresh water source for astronauts.

Advantages:

1. The energy conversion is very high (75-82%)
2. Noise & thermal pollution are low.
3. Maintainance cost is low.



Solid oxide fuel cell. (SOFC)

It is an electrochemical device that produce electricity directly from oxidising a fuel.

→ SOFC cell uses the solid oxide material as the electrolyte which conducts negative oxygen ions from cathode to anode.

→ Electrochemical oxidation of the hydrogen, carbon monoxide occurs on anode side

→ Reduction of oxygen to oxygen ions occurs at the cathode and these ions diffuse through the solid oxide electrolyte to the anode where electro chemically oxidise the fuel.

→ In this reaction water is given as byproduct and with two electrons.

→ These electrons flows through an external circuit, with the cycle repeats as the electrons enter the cathode material again.

Anode: $Ni - ZrO_2$ or $Co - ZrO_2$

Cathode: Strontium doped Lanthanum Magnate $LaMnO_3$

Electrolyte: Yttrium oxide (Y_2O_3)

Solid oxide material.

Chemical Reaction:

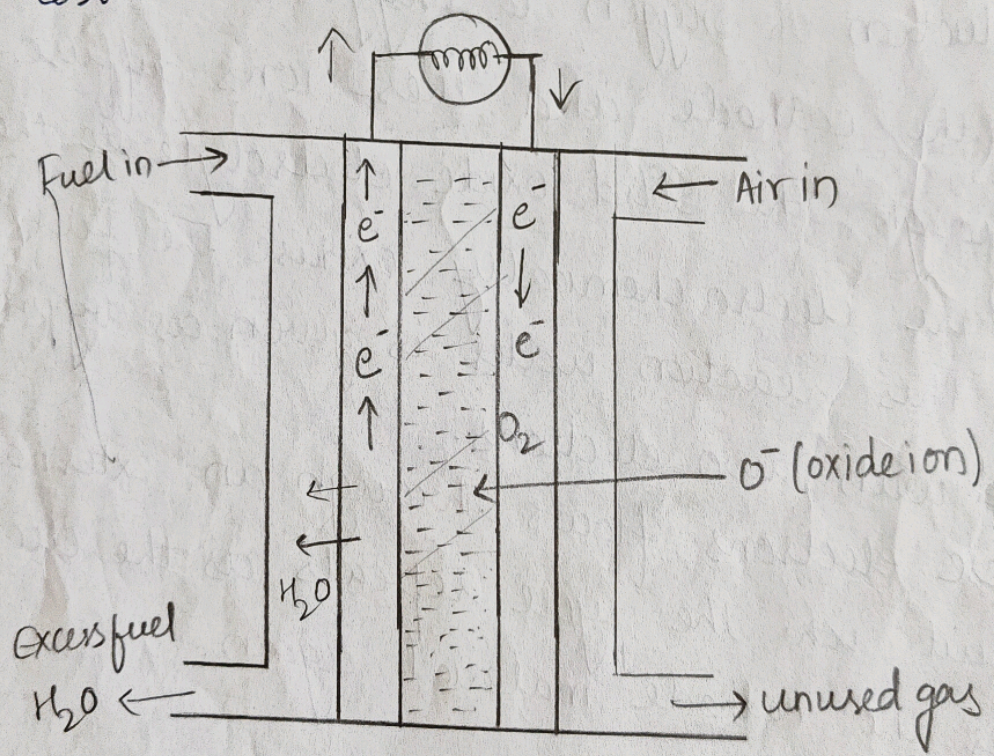
Anode: $O^{2-} + H_2 \longrightarrow H_2O + 2e^-$

Cathode: $\frac{1}{2}O_2 + 2e^- \longrightarrow O^{2-}$

$$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O.$$

Advantages:

High power efficiency, long term stability fuel flexibility, low emission and relatively low cost.



Solar cell or photovoltaic cell:

A solar cell is an electrical device that converts the energy of light into electricity by photovoltaic effect.

→ Solar cell, when it is exposed to light, can generate an electric current without being attached to any external voltage source.

→ The term photovoltaic comes from the greek word phos meaning light and volt is the unit of emf, which was named after inventer of battery Italian physicist Alessandro Volta.

Principle:

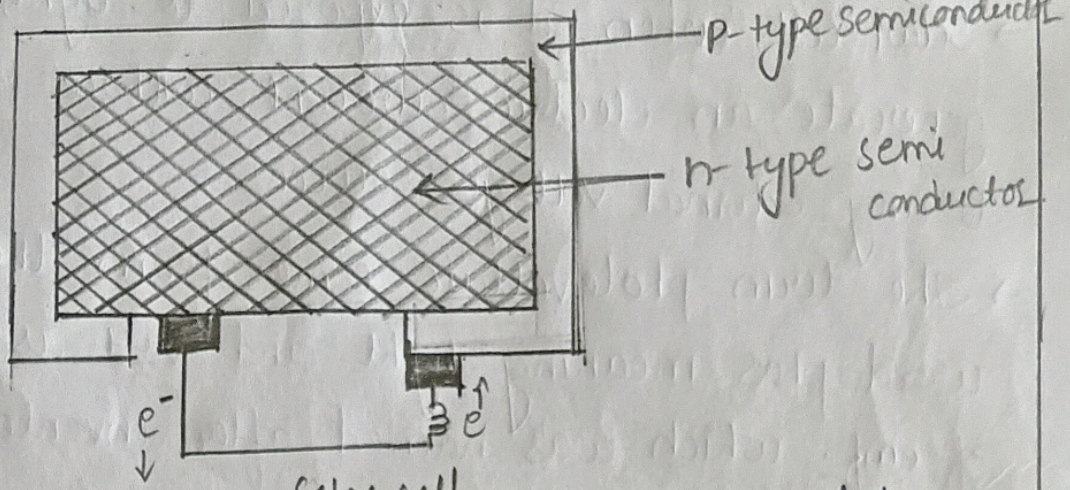
The basic principle involved in the solar cell is based on the photovoltaic effect.

→ When the solar rays falls on a two layer of semi-conductor device, a potential difference between the two layer is produced.

→ The potential difference causes flow of electrons and produces electricity.

Construction:

Solar cell consists of a p-type semiconductor such as Si doped with (B) and n-type semiconductor (such as Si doped with (P) They are in close contact with each other.



Solar cell

Working:

When the solar rays falls on the top layer of P-type semiconductor, the electrons from the valence band gets promoted to the conduction band and cross the p-n junction into n-type semiconductor.

→ There by potential difference between two layers is created, which causes flow of electrons.

→ Thus, when P and n layers are connected to an external circuit, electrons flows from n-layer to P-layers and hence current is generated.

Applications:

1. The main application of solar cell is to generate large scale or small scale electricity.
2. To make use of solar generated energy, the current is fed into electricity grid using inverters in stand alone system and batteries to store energy
3. Solar panels can be used for making power or recharge the portable device and heating water etc.
4. Solar panels can be used for solar street lighting, home lighting system and lanterns
5. It is used in electronic industry for calculators components, solar flash light.
6. Solar power not only helps preserving the environment but also a good economic renewable energy source.

Difference between primary cells and secondary cells

	Primary cell	Secondary cell.
1.	cell reaction is irreversible	1. cell reaction is reversible
2.	cell must be discarded after use.	2. It can be recharged.
3.	It is having relatively short shelf life	3. Have long shelf life.
4.	They cannot be used as storage device. Example: Dry cell, Zn-air cells.	4. They are used as storage cell. Example: Ni-cd, lead-Acid.

Difference between Battery and Fuel cell.

	Batteries	Fuel cell.
1.	A Battery is a device contains one or more electrochemical cells that convert chemical energy into electrical energy	1. A fuel cell is a device that can convert the chemica energy into electrical energy
2.	Battery stores chemical energy	2. Fuel cell does not store energy
3.	They can be recharged	3. They can not be recharged
4.	Efficiency is less.	4. Effeciency is more

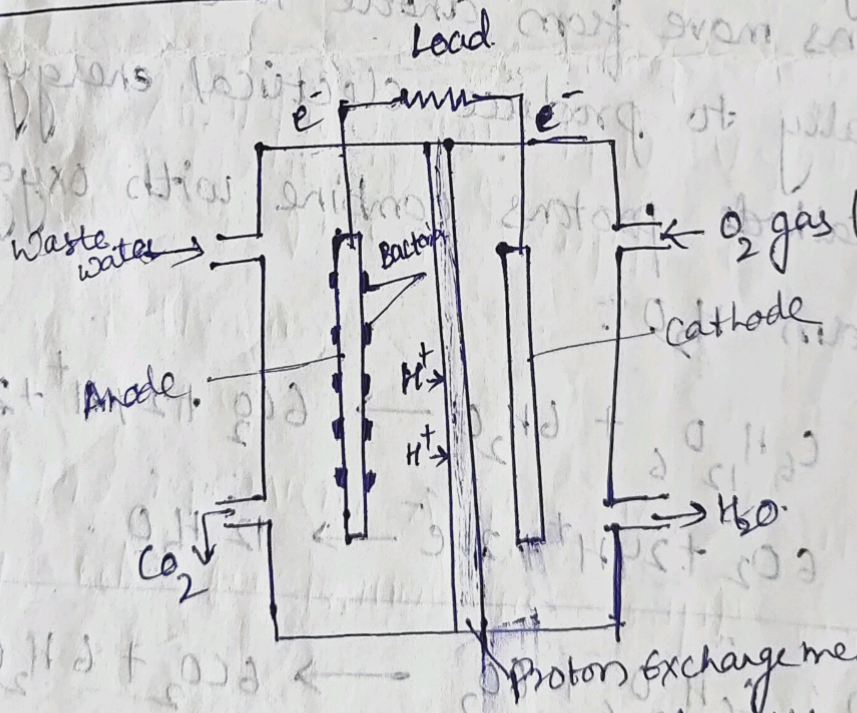
Microbial fuel cell!

A microbial fuel cell (MFC) is a device that converts chemical energy to electrical energy by the action of microorganisms.

- MFCs can be used in waste water treatment plants.

→ They can converts the organic matter in waste water into electricity and removes pollutants.

CONSTRUCTION!



- Anode: Graphite rod coated with bacteria.
- cathode: Graphite rod coated with platinum catalyst
- Electrolyte: proton Exchange Membrane.

Working:

→ MFC consists of anode, cathode & electrolyte

→ Anode chamber is anerobic.

→ cathode chamber is aerobic.

→ Anode & cathode are separated by electrolyte.

→ At anode microorganisms oxidise fuel to generate protons, electrons & CO_2

→ Protons move from anode to cathode through membrane

→ Electrons move from anode to cathode externally to produce electrical energy.

→ At cathode protons combine with oxygen to form H_2O.

Anode: $C_6H_{12}O_6 + 6H_2O \rightarrow 6CO_2 + 24H^+ + 24e^-$

cathode: $6O_2 + 24H^+ + 24e^- \rightarrow 12H_2O$

Net reaction: $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

Advantages:

→ Generates electical energy from organic matter

→ Removes toxic pollutants from waste water

Applications:

→ used for waste water treatment.

→ used in biosensing

→ used in robotics

→ powering underwater monitoring devices.