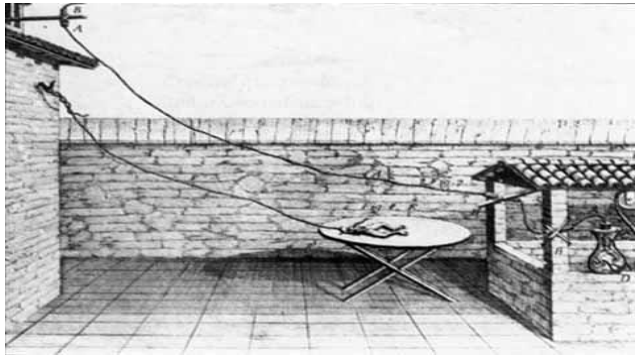
BATTERIES

1771-1800: The Galvani-Volta Controversy

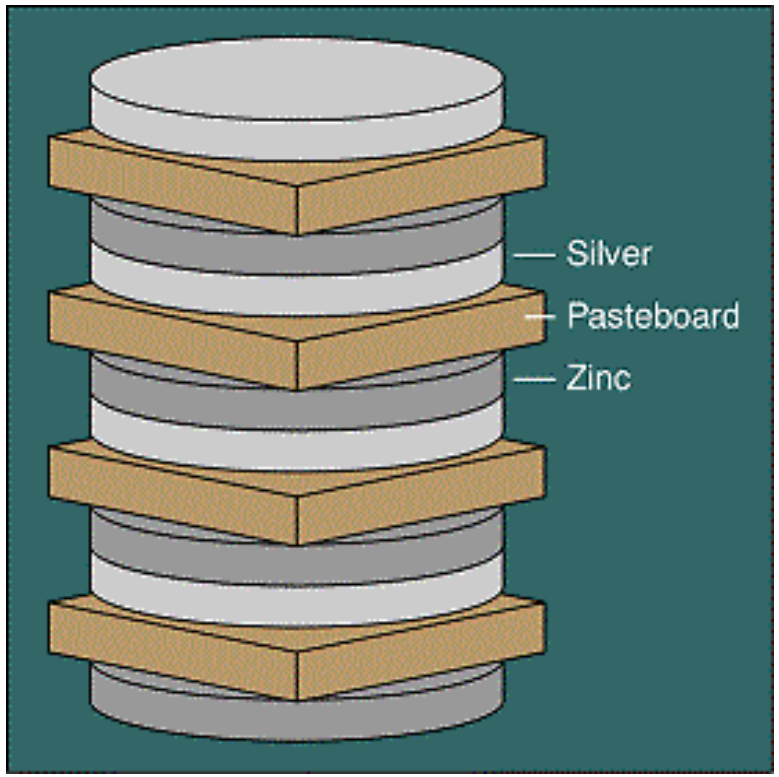
Luigi Galvani

“Animal Electricity



Alessandro Volta

1800: The First Battery (Voltaic Pile)



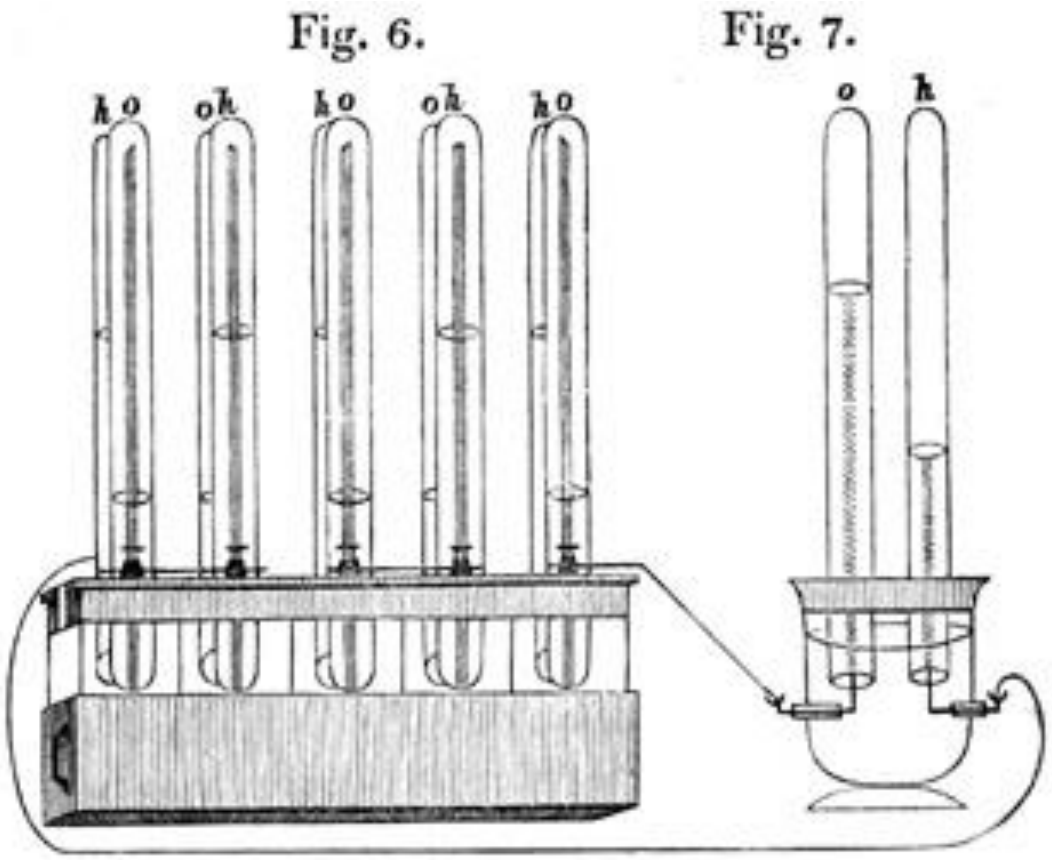
1801: Volta presenting his battery to Napoleon

1821: The First Electric Motor
1835: The First BEV (Battery Electric Vehicle)

Michael Faraday

Sibrandus Stratingh

1839: First Fuel Cell (Grove's "Gas Battery")



Sir William Grove


NOKIA


NOKIA
BL-5C

BATTERIES

They are electrochemical cells connected in series

Batteries are Store houses of electrical energy

They are used as a source of direct electric current at constant voltage.

They are classified into two types

i) Primary cell

ii) Secondary cell

Primary Batteries: These are non rechargeable & are meant for single use& discarded after use.

Secondary Batteries: Voltaic cells whose electrochemical reactions can be reversed by a current of electrons running through the battery after the discharge of an electrical current.

A secondary battery can be restored to nearly the same voltage after a power discharge.

Differences between Primary and secondary batteries:

Primary cells	Secondary cells
1. These are non-rechargeable and meant for a single use and to be discarded after use.	1. These are rechargeable and meant for multi cycle use.
2. Cell reaction is not reversible.	2. Cell reaction can be reversed.
3. Cannot be rechargeable.	
4. Less expensive.	3. Can be rechargeable.
5. Can be used as long as the materials are active in their composition. Eg: Leclanche cell, 'Li' Cells.	4. expensive. 5. Can be used again and again by recharging the cell. Eg; Lead- acid cell, Ni-cd cells.

PRIMARY CELL OR LECLANCHE CELL

In this cell the reactions are irreversible
It is also known as Dry cell

Anode- Zinc container
Cathode- Carbon rod

Anode reaction

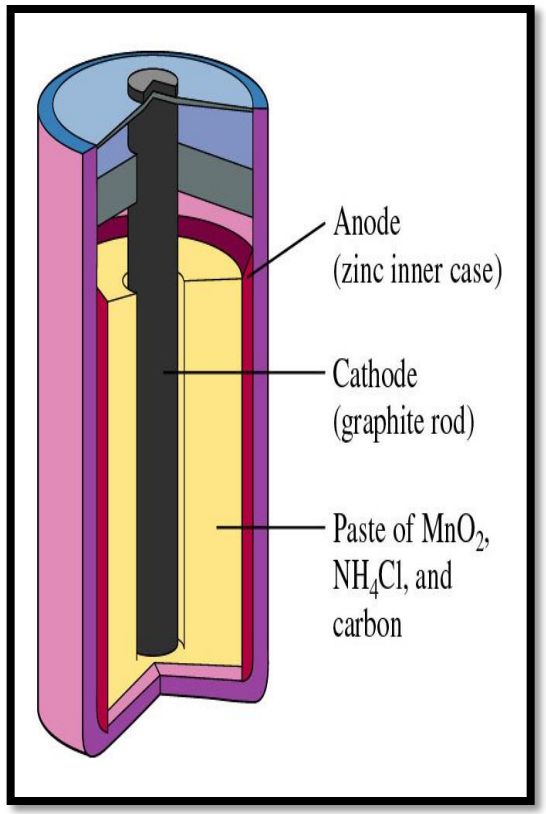
$Zn \rightarrow Zn^{2+} + 2e^-$

Cathode reaction

$2NH^{4+} + 2MnO_2 + 2e^- \rightarrow Mn_2O_3 + 2NH_3 + H_2O$

Cell reaction

$2MnO_2 + 2NH_4Cl + Zn \rightarrow Zn(NH_3)_2Cl_2 + Mn_2O_3 + H_2O$



Lead Storage battery

Anode reaction

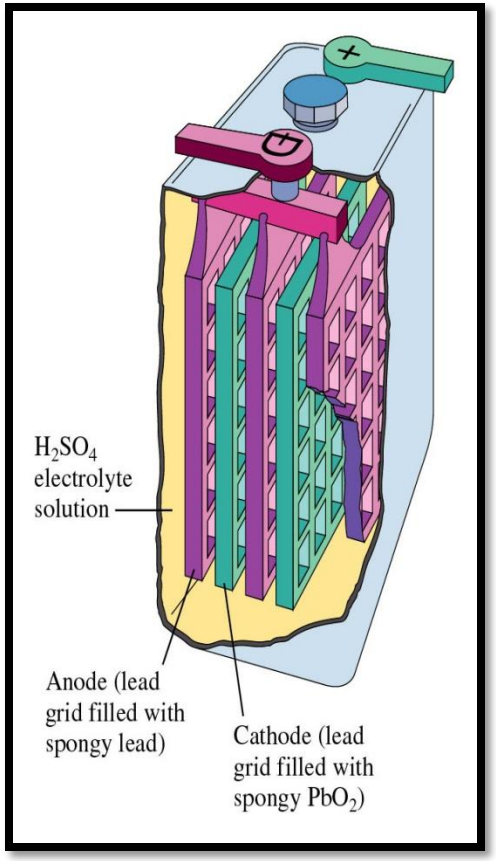
$Pb+HSO_4^- \rightarrow PbSO_4+H^++2e-$

Cathode reaction

$PbO_2+HSO_4^-+3H^++2e^- \rightarrow PbSO_4+2H_2O$

Cell reaction

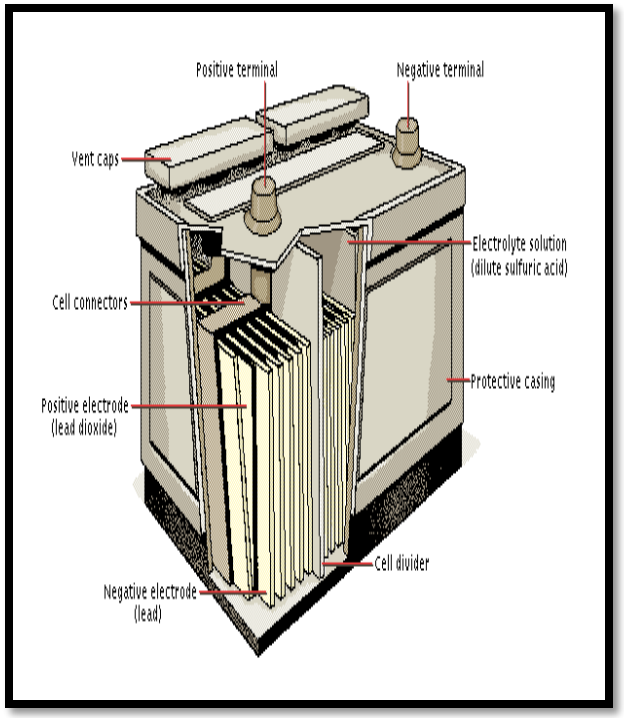
$Pb+PbO_2+2H^++2HSO_4^- \rightarrow 2PbSO_4+2H_2O$



$$Pb + PbO_2 + H_2SO_4 \rightarrow PbSO_4(s) + H_2O$$

Lead Acid Recharging

- Low self-discharge
  40% in one year (three months for Ni-Cd)
- No memory
- Cannot be stored when discharged
- Limited number of full discharges
- Danger of overheating during charging



Applications

1.Automobile and construction equipment.

2. Standby / backup system.

3. For engine batteries

Advantages:-

Low cost, long life cycle, Ability to withstand mistreatment, perform well in high and low temperature**.**

4. Lithium-ion battery (Li-ion Battery)

Li-ion batteries are secondary batteries.

- The battery consists of a anode of Lithium, dissolved as ions, into a carbon.
- The cathode material is made up from Lithium liberating compounds, typically the three electro-active oxide materials,

    - Lithium Cobalt-oxide ($LiCoO_2$)
    - Lithium Manganese-oxide ($LiMn_2 O_4$)
    - Lithium Nickel-oxide ($LiNiO_2$)

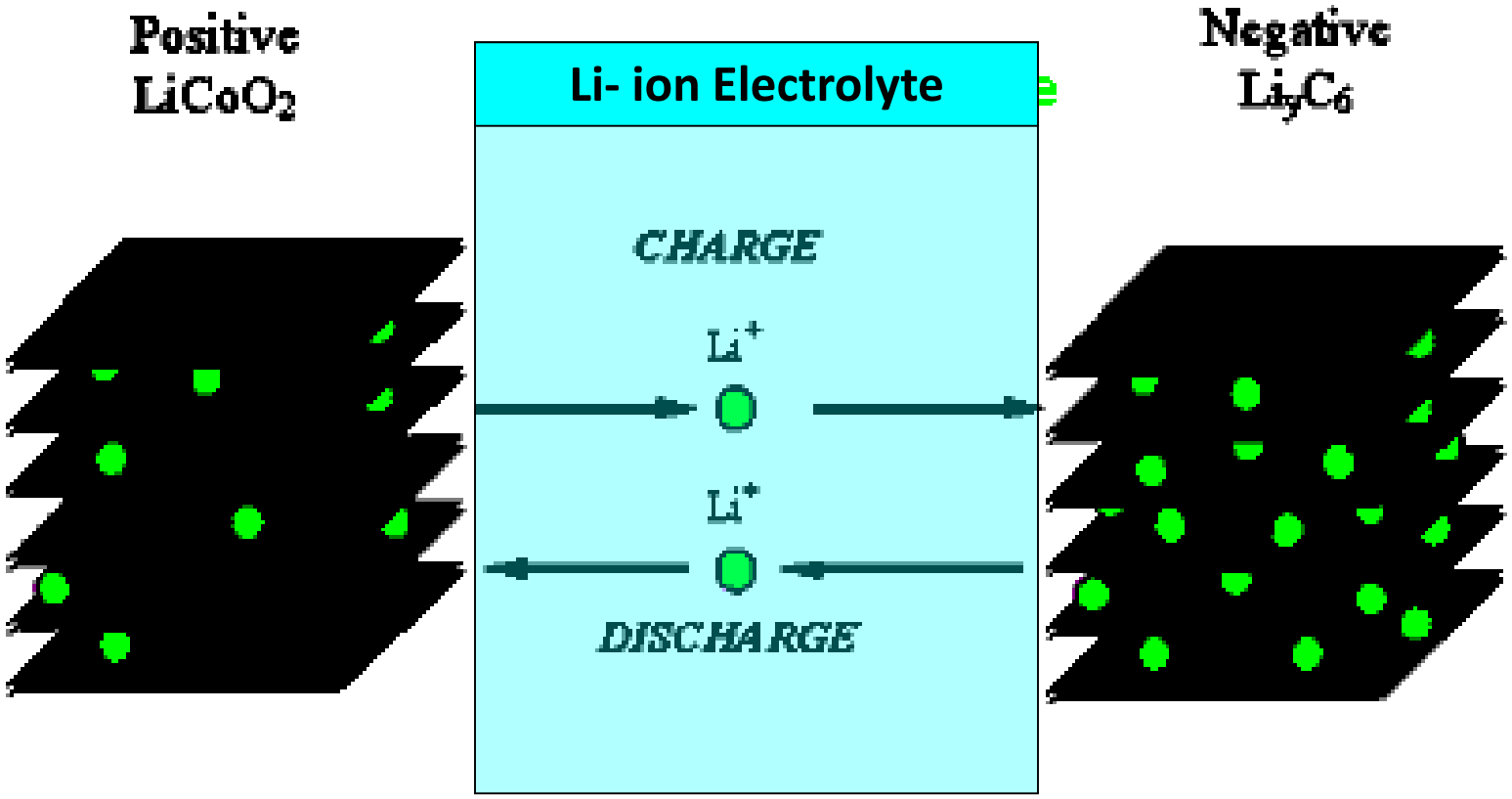
Principle

- During the charge and discharge processes, lithium ions are inserted or extracted from interstitial space between atomic layers within the active material of the battery.

- Simply, the Li-ion is transfers between anode and cathode through lithium Electrolyte.

- Since neither the anode nor the cathode materials essentially change, the operation is safer than that of a Lithium metal battery.

- The chemical reaction that takes place inside the battery is as follows, during charge and discharge operation:



Li-Ion battery Principle

Advantages

➢ They have high energy density than other rechargeable batteries

➢They are less weight

➢ They produce high voltage out about 4 V as compared with other batteries.

➢ They have improved safety, i.e. more resistance to over voltage.
No liquid electrolyte means they are immune from leaking. .

➢Fast charge and discharge rate

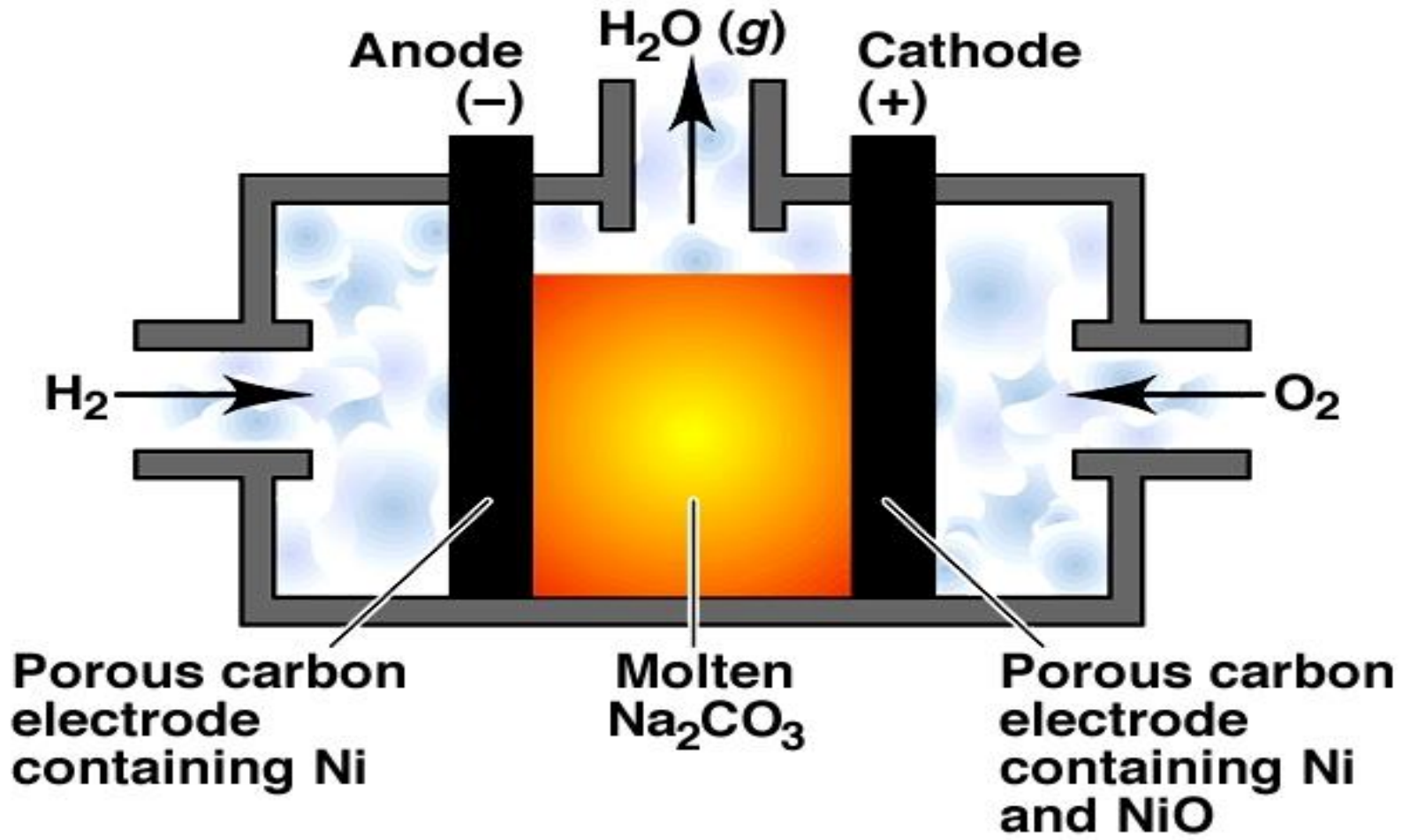
Disadvantage

➢ They are expensive
➢ They are not available in standard cell types.

Applications

- The Li-ion batteries are used in cameras, calculators
- They are used in cardiac pacemakers and other implantable device
- They are used in telecommunication equipment, instruments, portable radios and TVs, pagers
- They are used to operate laptop computers and mobile phones and aerospace application

Flow Batteries (Fuel Cells)



FUEL CELLS

The cell that converts energy of combustion of fuels like Hydrogen, Methane to electrical energy. Fuels are usually gas or liquid, with oxygen as the oxidant.….

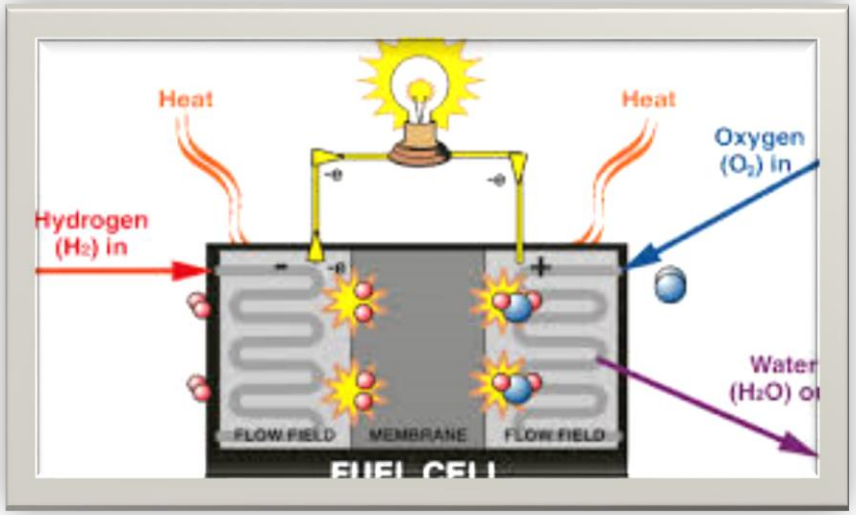
Different fuel cells are The direct conversion of chemical energy to electrical energy has 100%.

The cell representation is as follows.
Fuel/electrode//electrolyte//electrode//oxidant

Types of Fuels:

1.Hydrogen – Oxygen Fuel cell

2.Methanol –Oxygen fuel cell



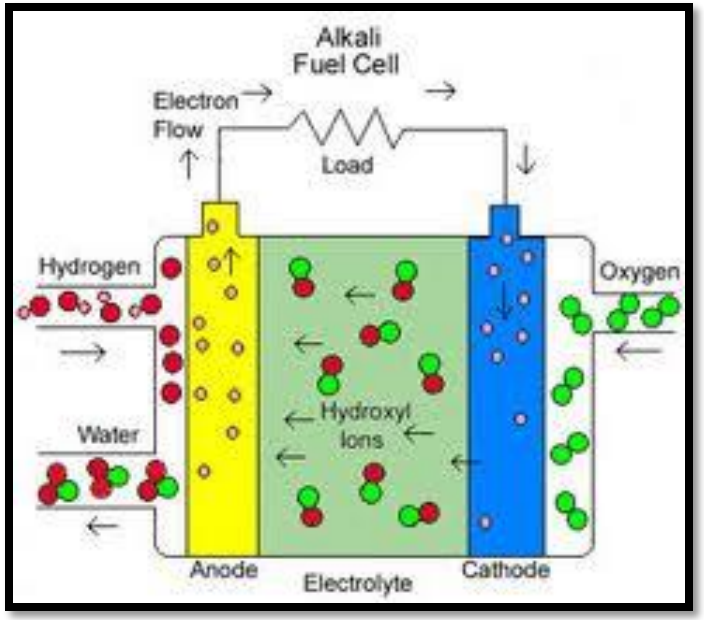
LIMITATIONS OF FUEL CELLS

- Large weight and volume of hydrogen gas fuel storage system
- High cost of Hydrogen gas, technological advances should bring the cost down
- Lack of infrastructure for distribution and marketing of Hydrogen gas.
- Most basic fuel cells suffer from carbon di oxide leakages and should be prevented from entering the cell and reacting with the electrolyte.

Hydrogen-Oxygen or Alkaline fuel cell

- In this fuel cell, electrolyte is 25-30% aqueous KOH.This cell make use of high purity of hydrogen as fuel &oxygen as oxidant.

- The reaction between H_2-O_2 takes place to produce water &excess electrons produces the electric current.

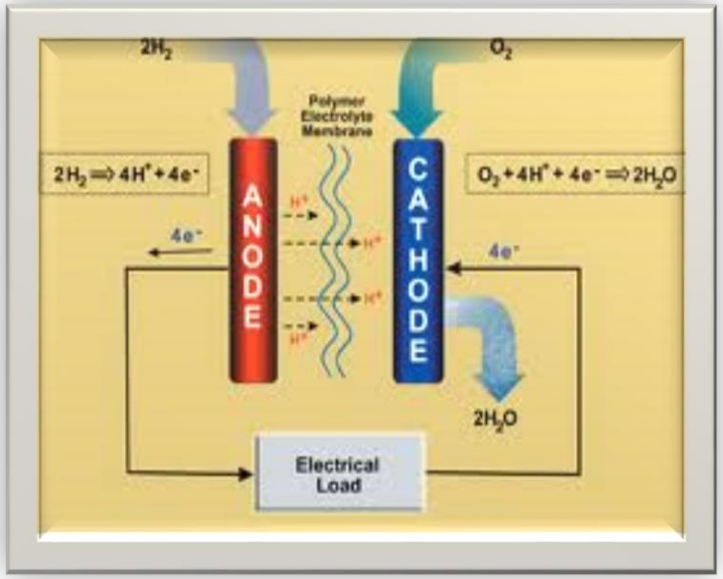


- Reactions:

  At anode: $2H_2+4OH^- \rightarrow 4H_2O+4e^-$

  At cathode: $O_2+2H_2O+4e^- \rightarrow 4OH^-$

  Net reaction: $2H_2+O_2 \rightarrow 2H_2O$



The product discharged is water &standard emf is 1.23volts.

Applications:

1. These are used as auxillary energy source in space, vehicles, submarines & military vehicles.

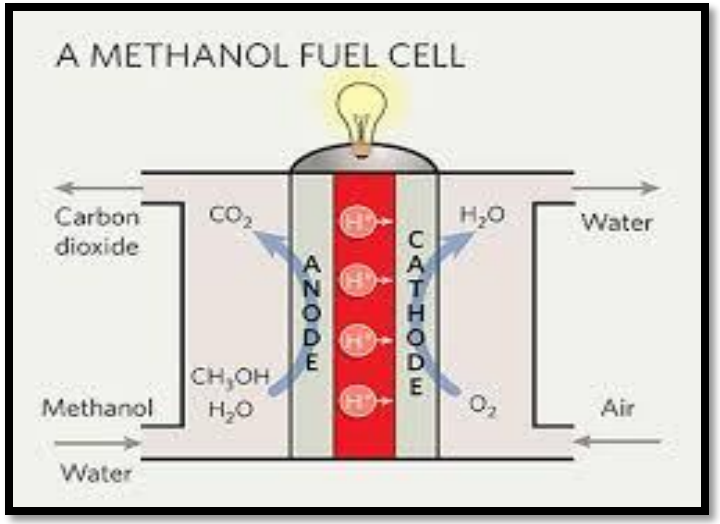
2. The product in this cell is water &it is used as valuable fresh water &source for astronauts.

Methanol-oxygen fuel cell:

- In this cell, CH_3OH is used as a fuel & O_2 as a oxidant to generate electric current. This cell has two electrodes.

- porous nickel electrode coated with pt/pd catalyst act as anode & coated with silver catalyst act as cathode.

- The electrolyte KOH taken is in between two electrodes.



Reactions:

- **At anode**: $CH_3OH + 6OH^- \rightarrow CO_2 + 5H_2O + 6e^-$

At cathode: $3/2O_2 + 3H_2O + 6e^- \rightarrow 6OH^-$

Net reaction: $CH_3OH + 3/2O_2 \rightarrow CO_2 + 2H_2O$

Advantages :

1.These cells are reasonably stable at all environmental conditions.

2.Easy to transport.

3.Do not require complex steam reforming operations.

4.Methanol posses less risk to aquatic plants, animals & human beings than gasoline.

Advantages of fuel cells

1.The reactants and products are environment friendly.

2.High efficiency of energy conversion from chemical energy to electrical energy.

3.The fuels and electrolyte materials are available in plenty and inexhaustible unlike fossil fuel.

4.Fuel cells are operatable to 200 degree centigrade and so finds applications in high temperature systems.

5.Fuel energy is economical and safe.

6.Fuel cells are compact & transportabe.


Thank
you!