Energy RE sources.

01. Distinguish between Nuclear fission and Nuclear fusion reaction.

Nuclear fission	Nuclear fusion
1. Breaking a heavy nucleus into smaller	Combination of two smaller nuclei.
2. Emits radioactive rays	Does not emit radioactive rays
3. Reaction takes place at ordinary temperature	At high temperature. > 10^6K.
4. It gives chain reaction.	No chain reaction
5. Emits neutron	Emits positron
6. It can be controlled	It cannot be controlled.
7. The mass number and atomic number of new elements are lower than the parent nucleus.	Higher than that of starting elements.
8. Ex: Fission reaction of $_{92}U^{235}$, power generation in Nuclear Power Plant, Kalpakkam&koodankulam, Tamilnadu.	Ex: Fission reaction takes place in sun.

02. Define Nuclear fission reaction. Explain with one example in detail.

NUCLEAR FISSION REACTION:-

The process of splitting of heavy nucleus into two or more smaller nuclei with simultaneous liberation of large amount of energy in the form of heat is known as Nuclear Fission Reaction.

Heavy Element $\xrightarrow{\text{Splitting}}$ Smaller Nuclei + Energy released [huge amount]

Ex:- Fission reaction of U^{235}

When U^{235} is bombarded by slow neutron, unstable U^{236} is formed. The unstable U^{236} then divides into two approximately equal nuclei with the release of neutrons and large amount of heat energy.

$$_{92}U^{235} + {}_{0}n^{1} \rightarrow [{}_{92}U^{236}] \text{ (Unstable)}$$

$$[{}_{92}U^{236}] \rightarrow {}_{56}Ba^{140} + {}_{36}Kr^{93} + 3\,{}_{0}n^{1}$$

$$[{}_{92}U^{236}] \rightarrow {}_{54}Xe^{144} + {}_{38}Sr^{90} + 2\,{}_{0}n^{1}$$

$$[{}_{92}U^{236}] \rightarrow {}_{55}Cs^{144} + {}_{37}Rb + 2\,{}_{0}n^{1}$$

* During the fission reaction, large amount of energy released.
* Heavy elements are bombarded by slow neutrons, split into two or more nuclei.
* More neutrons are produced by fission of each nucleus.
* Fission products are radioactive and giving α, β radiations.
* The atomic weight of fission products 70 to 160.
* Fission reactions are self-propagating chain reactions.
* The number of neutrons, resulting from a single fission is known as multiplication factor.

03. Explain Nuclear Reactor-Power Generator with neat diagram./ Light Water Reactor

Nuclear Reactor: A device used for power generation, in which a nuclear chain reaction is initiated, maintained and controlled to produce the heat energy is known as nuclear reactor

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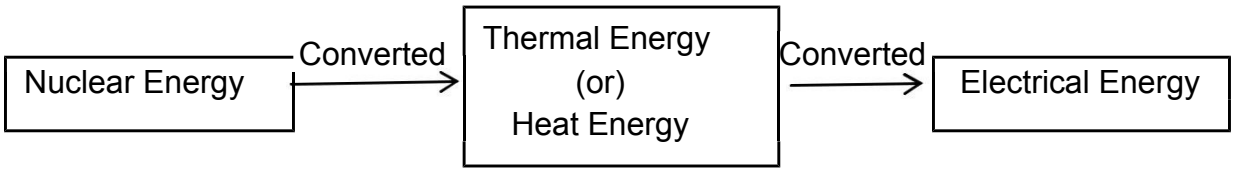
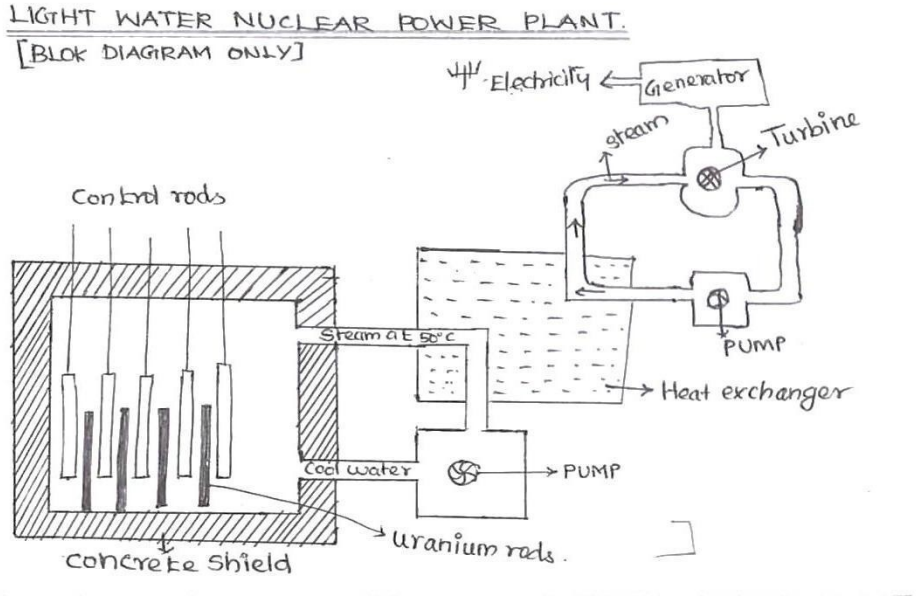




Components:

1) Fuel Rods: It produces heat energy and neutrons.
   Ex: Natural Uranium (99.28% U^{238} and 0.714 % U^{235}) and Pu^{239}
2) Control Rods: To keep power production at a steady state. Ex: Boron and Cadmium rods.
3) Moderators: Function to reduce the kinetic energy of fast fission neutrons to slow neutron and this is done in a small fraction of a second.
   Ex: Graphite, Be, Ordinary water and Heavy water.
4) Coolants: To remove the intense heat produced in the reactor and to bring it out for utilization. Ex: Ordinary water, Heavy water, liquid metals and gases.
5) Reflector: It placed around the core to reflect back some of the neutrons that leak out from the surface of the core.
6) Pressure vessel: It enclosed the core and reflector. It also provides the entrance and exit passages for coolant. (Pressure 200 kg/cm^2)
7) Shielding: To attentiate the Gama rays and other radiations coming out from the reactor. 2 Types. (i). Thermal shield (ii). Biological shield.
8) Turbine: The steam at high pressure, generated in the heat exchanger is used to operate a steam turbine, which derives a generator to produce electricity.

04. Explain Breeder reactor with reactions.

Breeder Reactor:- (2M/8M)

It is a reactor,

Which is used to convert non fissionable materials (U^{238}, Th^{232})

into fissionable material. (U^{235}, Pu^{239})

The fissionable nucleides are called fissile materials while the other non-fissionable are called fertile materials.

$$_{92}U^{238} + {}_{0}n^{1} \longrightarrow {}_{94}Pu^{239} + 2e^{-}$$

$$_{94}Pu^{239} + {}_{0}n^{1} \longrightarrow \text{Fission products} + 3\,{}_{0}n^{1}.$$

The breeder reactor produces more fissionable material than it uses. Hence Pu^{239} is a man-made nuclear fuel and is known as Secondary nuclear fuel.

Advantages (or) Significance:-

(1) As regeneration of fissile nucleided takes place, its efficiency is more.

(2) Fertile materials are formed like U^{238} & Th^{232}.

(3) Fissile materials like U^{235}, Pu^{239} are formed.

05. Define solar cell. Explain solar energy conversion in detail.

Solar cell = Photogalvaniccell : It is a device used for converting solar energy into electricity. It is made by interconnecting a large number of photovoltaic cells.

Solar Energy Conversion: It is the process of conversion of direct sunlight into more useful forms. Conversion may be in two forms. 1. Thermal Conversion. 2. Photo Conversion.

01. Thermal Conversion:

It involves absorption of thermal energy in the form of IR radiation. Temperature below $100^{o}C$, is useful for heating purpose of water and refrigeration.

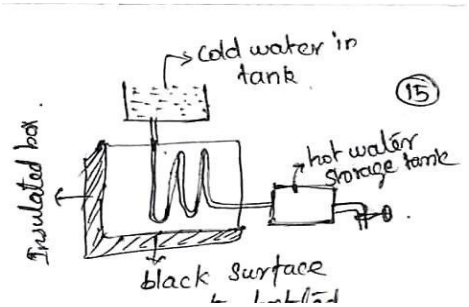
Methods: (i).Solar heat collectors. (ii).Solar water heater.

(i). Solar heat collectors: It consists of natural materials like stones, bricks which can absorb heat during the day time and release it slowly at night.

Uses: It is used for houses in cold condition.

(ii). Solar Water Heater:

It consists of an insulated box inside of which is painted with black paint. There is a provision for sun light absorption using a glass lid and store solar heat. Inside the black painted, copper coil and cold water is flow in and gets heated and storage in a tank.

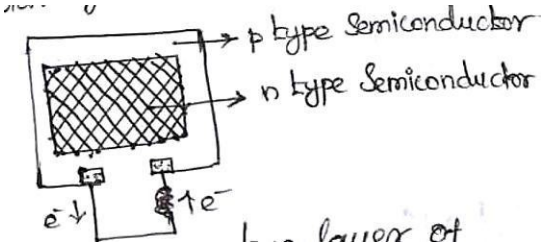


2. Photo Conversion: It involves conversion of light energy directly into electrical energy.

Methods: Solar Cell.

Solar Cell: Ex: Solar light, solar pump, solar battery.

It is a device, converting solar energy directly into electrical energy.



Principle: When solar rays fall on a two layer of semi-conductor devices, a potential difference between the two layers is produced. This potential difference causes flow of electrons and produces electricity.

Working: When the solar ray falls on the top layer and the e-s promoted to the conduction into n-type semiconductor. The potential difference occurs; it should lead current increasing (i.e) flow e-s. They are connected with an external circuit, and current is generated.

Applications of Solar Energy :(i). Used in calculators,Watches, etc.
(ii). Used to drive Vehicles.
(iii). Used in boilers to produce hot water for domestic and Industrial uses.
(iv). Used for lighting purposes. (v). Used as a source power in space crafts and satellites. (vi). Used for producing hydrogen by hydrolysis of H_2O.

Demerits of Solar Energy: (i). Huge capital cost.
(ii). Not available during night and cloudy days. (iii). Storage of energy is not possible.

06. Write a short note on Wind Energy.

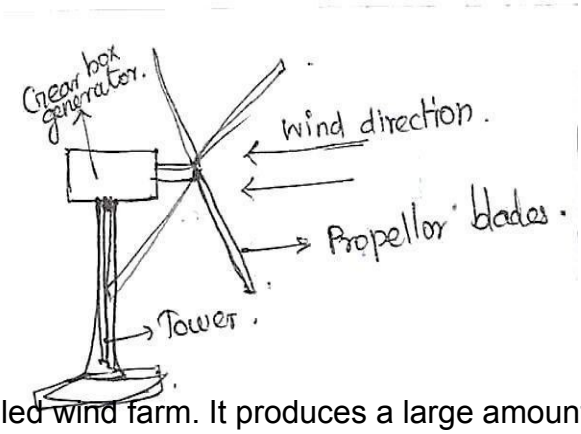
Moving energy is called Wind.

Energy recovered from the force of the wind is called wind energy.

The wind energy is harnessed by making use of wind mills.

01.Wind Mills:

The strikes of blowing wind on blades of the wind mill make it rotating continuously. The rotational motion of the blade drives a number of machines like water pump, flour mills and electric generators.



Wind mills are capable of generating about 100 kw electricity.

02. Wind Farms.

It is known as the large number of joining wind mills called wind farm. It produces a large amount of electricity.

The minimum speed required for working of a wind generator is 15

km/hr 03. Other methods: (i). Sky Sail (ii). Ladder mill. Advantages/

Merits of Wind energy:

i. It does not cause any Air pollution.
ii. It is very cheap and economic.
iii. It is renewable.

Disadvantages of Wind energy:

i. It produces noise.
ii. It produces unwanted sound.
iii. Affects bird's life.
iv. Affected to the radio signals.

7. **Define Battery. Explain with its types.**

Battery:

It is a device, converted chemical energy into electrical energy. It contains several anodes and cathodes.

It is an arrangement of several electrochemical cells connected in series and it can be used as a source of direct electric current. (D.C).

TYPES OF BATTERIES:

1. PRIMARY BATTERY

i. It is known as Non-Reversible battery.
ii. Electrode and electrode reactions cannot be reversed by passing an external current.
iii. Reactions take place only once and after use they become dead.
iv. They are not chargeable.
v. Ex: Dry Cell, Mercury Cell, Leclanche's cell.

2. SECONDARY BATTERY

i. It is known as Reversible battery.
ii. Electrode and electrode reactions are reversiblewhen an external current is passing
iii. It can be recharged again and again.
iv. Also called as Storage cells or Accumulators.
v. Ex: Lead-Acid Battery, Ni-Cd.

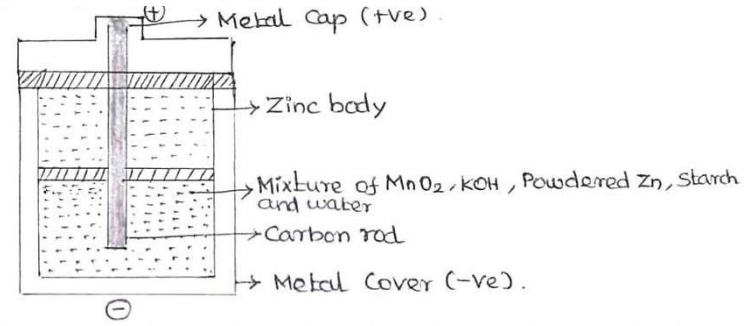
03. FLOW BATTERY

In these cells, the reactants, products and electrolytes and continuously passing through the cell. Here chemical energy is converted to electrical energy.

Ex: H_2-O_2 fuel cell.

08. Explain Dry cell with neat diagram and cell reactions.

Anode	Zinc body
Cathode	Carbon rod / Graphite rod
Electrolyte	Powdered KOH, MnO_2 in the form of paste.



Alkaline battery consists of electrolyte KOH and a Zinc cylinder filled with powdered Zn, KOH and MnO_2 in the form of paste using starch and water. A carbon rod [Graphite] acts as a cathode and it is immersed in the electrolyte in the centre of the cell. The outside cylindrical zinc body acts as an anode.

At Anode: $Zn + 2OH^- \longrightarrow Zn(OH)_2 + 2e^-$

At Cathode : $2MnO_2 + H_2O + 2e^- \longrightarrow Mn_2O_3 + 2OH^-$

Overall : $Zn + 2MnO_2 + H_2O \longrightarrow Zn(OH)_2 + Mn_2O_3$

Advantages:

i. Zinc doesn't dissolve in a basic medium.
ii. Its life is longer than dry battery because there is no corrosion on Zn.
iii. It maintains its voltage, when the current is drawn from it.

Uses:

It is used in calculators and watches.

09. Explain Lead acid storage battery.

Cell Representation: $Pb/Pb(SO)_4//H_2(SO)_{4(aq)}/PbO_2/Pb$

Anode	Lead - Pb
Cathode	Lead Oxide PbO_2
Electrolyte	Sulphuric acid - $H_2(SO)_4$

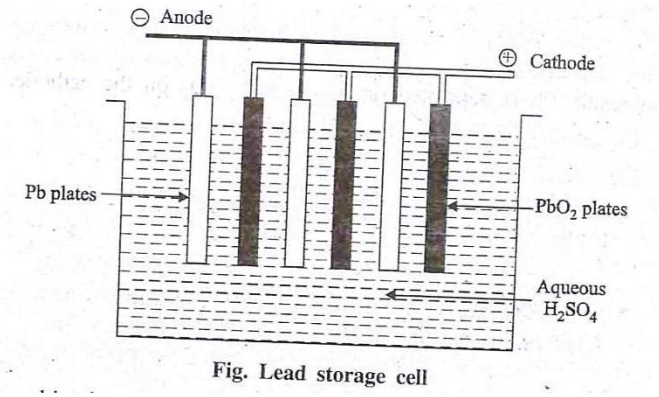


Fig. Lead storage cell

This is also a rechargeable battery.

It consists of number of voltaic cells. In each cell, anode is Pb plate and cathode is PbO_2

A known number of lead plates are connected with parallel and a number of PbO_2 plates and also connected in parallel. Various plates are separated by insulators like glass fibre. The total anodes and cathodes are immersed in dil.$H_2(SO)_4$ Solution.

Cell reactions: Discharging.

At Anode : $Pb_{(S)} + SO_4^{2-} \longrightarrow PbSO_4 + 2e^-$

At Cathode : $PbO_{2(S)} + 4H^+ + SO_4^{2-} + 2e^- \longrightarrow PbSO_{4(S)} + 2H_2O$

Overall : $Pb_{(S)} + PbO_{2(S)} + 2H_2SO_{4(aq)} \rightarrow 2PbSO_{4(S)} + 2H_2O + Energy$

Advantages:

(i). It is made easily.

(ii). It produces very high current.

(iii). Effective one at low temperature.

(iv). Self- discharging rate is low.

Uses:

(i). Used in automobiles like Car, Bus, Van, Lorry, Bike etc.

(ii). Used in Hospitals, Powerstations, Telephoneexchanges etc.

10. Explain Hydrogen- Oxygen Fuel cell / [$H_2 – O_2$] Fuel cell.

Fuel Cell: It is a device in which the chemical energy of the fuel hydrogen is directly converted into electricity without combustion.

Anode	Hydrogen
Cathode	Oxygen (oxidizer)
Electrolyte	25% KOH or NaOH

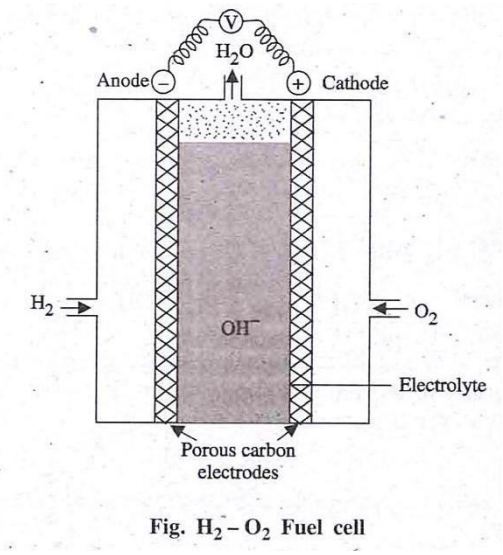


Fig. $H_2 – O_2$ Fuel cell

Two porous electrodes – Made of compressed carbon containing a catalyst like pt / pd.

It consists of two porous electrodes anode and cathode. In between two electrodes an electrolytic solution 25% KOH or NaOH filled.

When H_2 is bubbled through the anode compartment, where it is oxidized. The O_2 is bubbled at the cathode compartment where it is reduced.

At Anode: $H_2 + 2OH^- \longrightarrow 2H_2O + 2e^-$ ×

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

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

The emf of the cell = 0.8 to 1.0 V.

Merits:

i. High efficiency.
ii. No unwanted noise and less maintenance.
iii. No pollution
iv. No need to change electrode often.

Uses:

i. Used in military vehicles and space vehicles.
ii. $H_2 – O_2$ fuel cell, the product is water, so no need of fuel because fuel is water.

11. Explain the construction and working of Lithium ion storage battery

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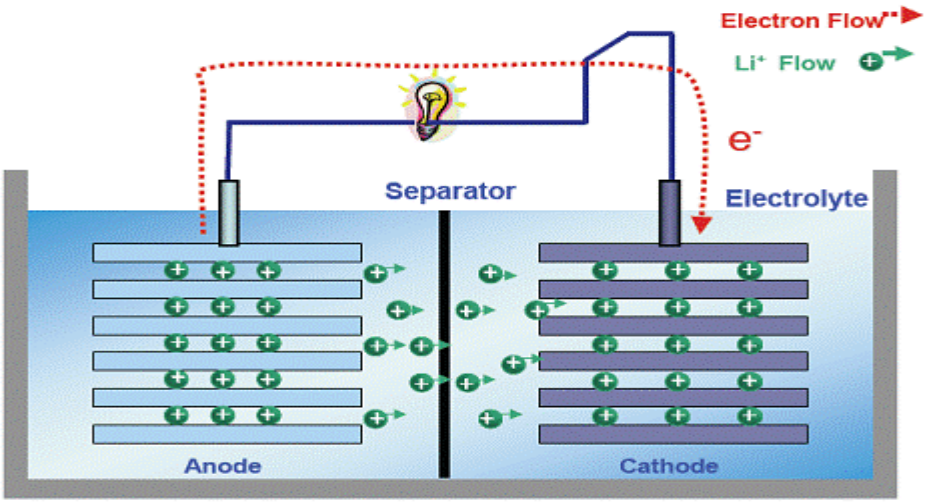


Lithium ion batteries have become a key component of portable electronic devices as they offer high energy density, flexible lightweight design and a longer cycle life than other battery systems. More efficient batteries are required in the development of advanced transportation technologies in order to reduce the use of imported oil and the emission of greenhouse gas.

A **lithium-ion battery** or **Li-ion battery** (abbreviated as **LIB**) is a type of rechargeable battery in which lithium ions move from the negative electrode to the positive electrode during discharge and back when charging. Li-ion batteries use an intercalated lithium compound as one electrode material, compared to the metallic lithium used in a non-rechargeable lithium battery. Organic solvents are used as the electrolyte.

Working

Both electrodes allow lithium ions to move in and out of their structures with a process called *insertion* (*intercalation*) or *extraction* (*deintercalation*), respectively.

During discharge, the (positive) lithium ions move from the negative electrode to the positive electrode through the electrolyte while the electrons flow through the external circuit in the same direction.

When the cell is charging, the reverse occurs with the lithium ions and electrons moved back into

the negative electrode in a net higher energy state.

The full reaction being:

$LiCoO_2 + C \longleftrightarrow Li_{(1-x)}CoO_2 + Li_xC$

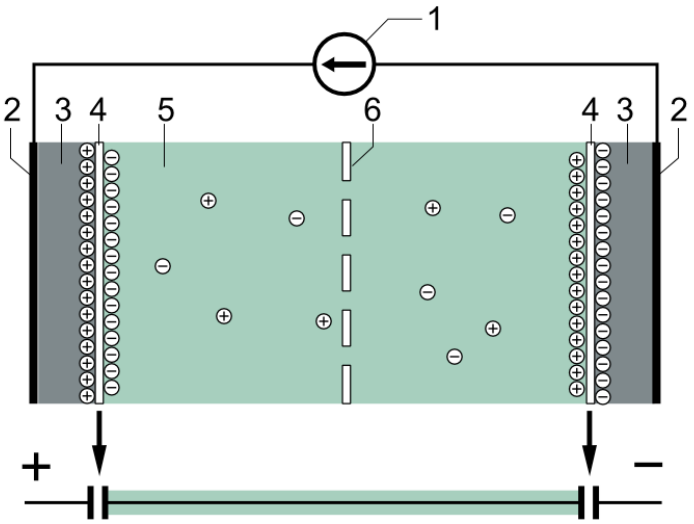
Applications

LIBs are also growing in popularity for military, battery electric vehicle and aerospace applications.

11. Discuss the super capacitor in detail.

A **supercapacitor** (**SC**) also electric double-layer capacitor (EDLC), also called **supercap**, **ultracapacitor** or **Goldcap**) is a high-capacity capacitor with capacitance values much higher than other capacitors (but lower voltage limits) that bridge the gap between electrolytic capacitors and rechargeable batteries. They typically store 10 to 100 times more energy per unit volume or mass than electrolytic capacitors, can accept and deliver charge much faster than batteries, and tolerate many more charge and discharge cycles than rechargeable batteries.

Unlike ordinary capacitors, supercapacitors do not use the conventional solid dielectric, but rather, they use electrostaticdouble-layer capacitance and electrochemical pseudocapacitance, both of which contribute to the total capacitance of the capacitor, with a few differences:



1) power source, 2) collector, 3) polarized electrode, 4) Helmholtz double layer, 5) electrolyte having positive and negative ions, 6) separator.

Working

- There are two carbon sheet separated by separator.
- The geometrical size of carbon sheet is taken in such a way that they have a very high surface area.
- The highly porous carbon can store more energy than any other electrolytic capacitor.
- When the voltage is applied to positive plate, it attracts negative ions from electrolyte.
- When the voltage is applied to negative plate, it attracts positive ions from electrolyte.
- Therefore, there is a formation of a layer of ions on the both side of plate. This is called 'Double layer' formation.
- For this reason, the ultracapacitor can also be called Double layer capacitor.
- The ions are then stored near the surface of carbon.
- The distance between the plates is in the order of angstroms.

Advantage

- Long life: It works for large number of cycle without wear and aging.
- Rapid charging: it takes a second to charge completely
- Low cost: it is less expensive as compared to electrochemical battery.
- High power storage: It stores huge amount of energy in a small volume.
- Faster release: Release the energy much faster than battery.

Disadvantage

- They have Low energy density
- Individual cell shows low voltage
- Not all the energy can be utilized during discharge
- They have high self-discharge as compared to battery.
- Voltage balancing is required when more than three capacitors are connected in series.

Applications

- They are used in electronic applications such as cellular electronics, power conditioning, uninterruptible power supplies (UPS),
- They used in industrial lasers, medical equipment.
- They are used in electric vehicle and for load leveling to extend the life of batteries.
- They are used in wireless communication system for uninterrupted service.
- There are used in VCRs, CD players, electronic toys, security systems, computers, scanners, smoke detectors, microwaves and coffee makers.