

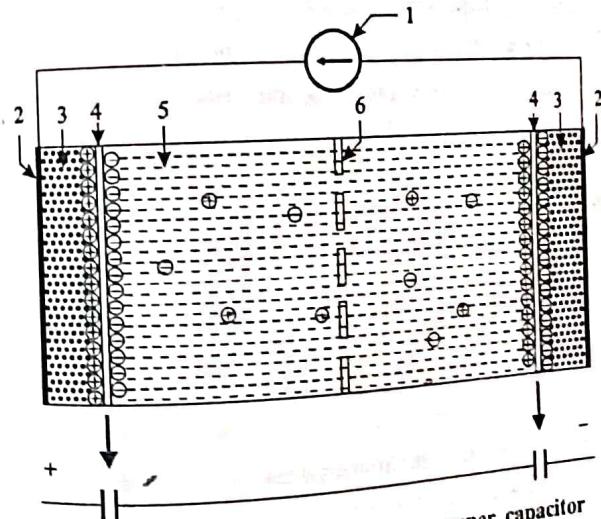
**Design of super capacitor**

Super capacitor (Electro-chemical capacitor) consists of two electrodes (made from metal coated with a porous substance like powdery activated carbon) separated by an ion-permeable membrane (separator) and dipped in an electrolyte, containing positive and negative ions, connecting both the electrodes.

**Working**

When the electrodes are connected to the power source, ions in the electrolyte form electric double layers (Helmholtz electrical double layer) of opposite polarity to the electrodes polarity, creating an electric field between them.

For example, positively polarized electrodes will have a layer of negative ions at the electrode/electrolyte interface. Similarly negatively polarised electrodes will have a layer of positive ions at the electrode/electrolyte interface.



**Fig. 9.6 Typical construction of a super capacitor**

1. Power source
2. Collector
3. Polarized electrode
4. Helmholtz double layer
5. Electrolyte having positive and negative ions
6. Separator

4. Hydrogen is not present as it is, but always present in combined form with either oxygen or some other element, so it must be separated first.
5. While using  $H_2 - O_2$  fuel cell in an automobile, a high pressure must be created inside the engine, which is risky.

### 9.5.2 Advantage and Disadvantages of Fuel cells

#### Advantages of Fuel cells

1. Fuel cells are efficient (75%) and take less time for operation.
2. It is pollution free technique.
3. It produces electric current directly from the reaction of a fuel and an oxidiser.
4. It produces drinking water.

#### Disadvantages of Fuel cells

1. Fuel cells can not store electric energy as other cells do.
2. Electrodes are expensive and short lived.
3. Storage and handling of hydrogen gas is dangerous.

## 9.6 SUPER CAPACITOR

Super capacitor is a high capacity capacitor with capacitance value much higher than other capacitor. They store 10 to 100 times more energy per unit volume and deliver charge much faster than batteries.

Unlike ordinary capacitors, super capacitors, do not use the conventional solid dielectric, but rather they use electrostatic double-layer capacitance.

This electric field polarizes the dielectric, so its molecules lineup in the opposite direction to the field and reduce its strength. It means that it stores more electrical energy at an electrode-electrolyte interface.

### Advantages

1. It is highly safe
2. Its life time is very high (10 to 20 years)
3. It can be cycled millions of time
4. It can be charged in seconds
5. It provides high power density and high load currents
6. Its performance is excellent even at low temperature ( $-40^{\circ}\text{C}$ )

### Disadvantages

1. Cost per watt is high
2. It cannot be used as source for continuous power supply
3. If higher voltage is required, the cells must be connected in series.
4. High self-discharge, it is higher than most batteries.

### Applications

Super capacitors are used in many power management applications like,

1. Voltage stabilization in start/stop system
2. Energy harvesting
3. Kitchen appliances
4. Regenerative braking system
5. Consumer electronics
6. Wind energy
7. Utility meters
8. Remote power for sensors, LEDs, switches
9. Energy efficiency and frequency regulation