MODULE -V

ENERGY SOURCES & STORAGE DEVICES

5.5 $H_2 – O_2$ Fuel Cell

5.5.1 Microbial fuel cell (MFC)

5.5.2 Super capacitors

5.5 $H_2 – O_2$ Fuel Cell

It is the simplest fuel cell.

Description

- Fuel –H_2
- Oxidation – O_2
- Electrolyte – liq. NaOH(or) KOH (25%)
- Anode & cathode – porous electrode made of compressed carbon (Graphite rod), with little amount of catalyst (Pt, Pd, Ag)
- Electrodes are connected.

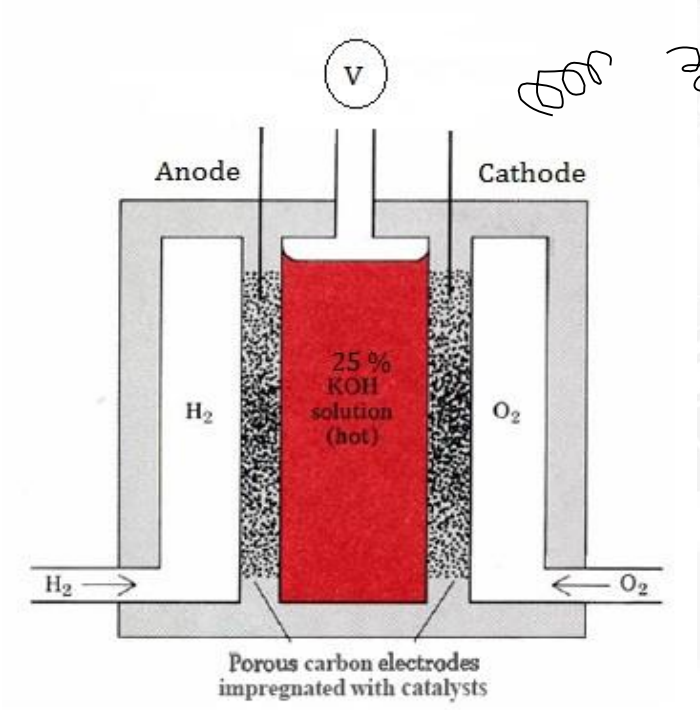

Fig:1-Hydrogen-oxygen fuel cell

Source: physical chemistry by Arun paul

Working

At Anode

- H_2 gas is bubbled through anode compartment

- H_2 is oxidized

$$2H_2 \longrightarrow 4H^+ + 4e^-$$

At cathode

- O_2 gas is bubbled through cathode compartment
- O_2 is reduced

$$O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O$$

Over all Reaction

$$2H_2 + O_2 \longrightarrow 2H_2O$$

Applications

- Used as energy source in space vehicles, sub marines tec.
- The product obtained water is a source of freshwater for the astronauts.

Advantages

- Efficiency is 70% greater than other energy sources.
- The products formed is harmless (water)
- There is no noise, thermal-pollution.

Fuel Battery

A large number of fuel cells are connected in series to from a Fuel battery.

5.5.1 Microbial fuel cell (MFC)

A Microbial fuel cell (MFC) is a device that converts chemical energy to electrical energy by the action of microorganisms. These electrochemical cells are constructed

using either a bioanode and/or a biocathode. Most MFCs contain a membrane to separate the compartments of the anode (where oxidation takes place) and the cathode (where reduction takes place). Microbial fuel cell (MFC) is a type of bioelectrochemical fuel cell system that generates electric current by diverting electrons produced from the microbial oxidation of reduced compounds (also known as fuel or electron donor) on the anode to high-energy oxidized compounds such as oxygen (also known as oxidizing agent or electron acceptor) on the cathode through an external electrical circuit.

Applications

Power generation

MFCs are attractive for power generation applications that require only low power, but where replacing batteries may be impractical, such as wireless sensor networks. Wireless sensors powered by microbial fuel cells be used for remote monitoring (conservation)

Virtually any organic material could be used to feed the fuel cell, including coupling cells to wastewater treatment plants.

Education

Soil-based microbial fuel cells serve as educational tools, as they encompass multiple scientific disciplines (microbiology, geochemistry, electrical engineering, etc.)

Biosensor

The current generated from a microbial fuel cell is directly proportional to the organic-matter content of wastewater used as the fuel. MFCs can measure the solute concentration of wastewater (i.e., as a biosensor).

Wastewater treatment

MFCs are used in water treatment to harvest energy utilizing anaerobic digestion. The process can also reduce pathogens.

5.5.2 SUPER CAPACITORS:

A **super capacitor** (**SC**), also called an **ultra capacitor**, is a high-capacity capacitor with a capacitance value much higher than other capacitors, but with lower voltage limits, that bridges the gap between electrolytic capacitors and rechargeable batteries. It typically stores 10 to 100 times more energy per unit volume or mass than electrolytic capacitors, can accept and deliver charge much faster than batteries, and tolerates many more charge and discharge cycles than rechargeable batteries.

Super capacitors are used in applications requiring many rapid charge/discharge cycles, rather than long-term compact energy storage — in automobiles, buses, trains, cranes and elevators, where they are used for regenerative braking, short-term energy storage, or burst-mode power delivery. Smaller units are used as power backup for static random- access memory (SRAM).

Unlike ordinary capacitors, super capacitors do not use the conventional solid dielectric,rather, they use electrostatic double-layer capacitance and electrochemical pseudo capacitance, both of which contribute to the total capacitance of the capacitor, with a few differences:

Electrostatic double-layer capacitors (**EDLCs**) use carbon electrodes or derivatives with much higher electrostatic double-layer capacitance than electrochemical pseudo capacitance, achieving separation of charge in a Helmholtz double layer at the interface between the surface of a conductive electrode and an electrolyte. The separation of charge is of the order of a few angstroms (0.3–0.8 nm), much smaller

than in a conventional capacitor.

Electrochemical pseudo capacitors use metal oxide or conducting polymer electrodes with a high amount of electrochemical pseudo capacitance additional to the double-layer capacitance. Pseudo capacitance is achieved by Faradaic electron charge-transfer with redox reactions, intercalation or electro sorption.

Hybrid capacitors, such as the lithium-ion capacitor, use electrodes with differing characteristics: one exhibiting mostly electrostatic capacitance and the other mostly electrochemical capacitance.

Principle:

Electrical energy is stored electrostatically by polarizing an electrolytic solution.

Construction:

It consists of two porous electrodes, an electrolyte, a separator and a current collector.

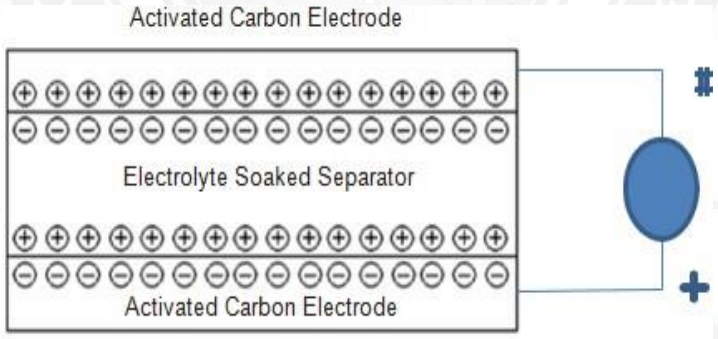

Fig:2- Super capacitor

Source: Engineering chemistry by Dr.Ravikrishnan

Working:

- When voltage is applied to the +ve plate, it attracts the –ve ions from the electrolyte.When voltage is applied to the –ve plate, it attracts the +ve ions from the electrolyte.This results in formation of a double layer.
- The ions are stored near the surface of the carbon.

- The separator prevents the movement of ions across the electrodes.
- Huge amount of energy is stored due to the large surface area provided by the porous carbon electrodes.

Advantages:

- It works for long time without wearing and ageing.I
- t takes seconds to charge completely.
- It is of low cost. Faster energy release.