Microbial Fuel Cell

Name: Nishanth   Reg.No:21BCE7924

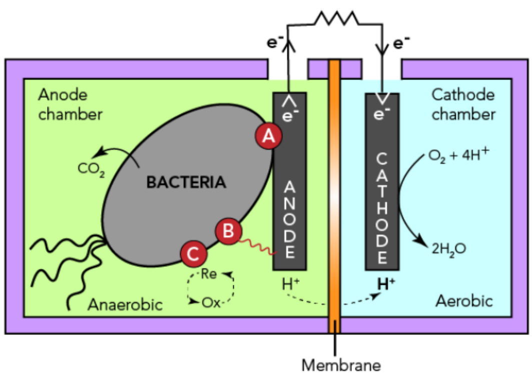
Microbial Fuel Cell:

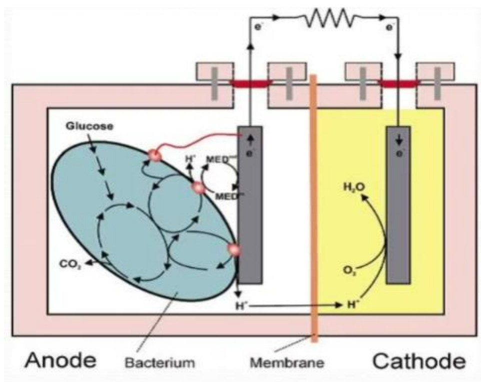
A microbial fuel cell (MFC) is a device that converts chemical energy to electrical energy by the action of micro-organisms. These electrochemical cells are constructed using either a bioanode or a bio cathode.

History of development:

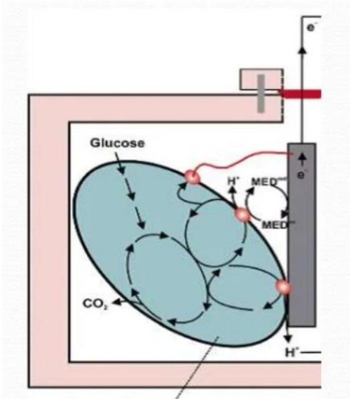
The idea of using microbes to produce electricity was conceived in the early twentieth century. Michael Cress Potter initiated the subject in 1911. Potter managed to generate electricity from Saccharomyces cerevisiae, but the work received little coverage. In 1931, Barnett Cohen created microbial half fuel cells that, when connected in series, were capable of producing over 35 volts with only a current of 2 milliamps. The first MFCs, demonstrated in the early 20th century, used a mediator: a chemical that transfers electrons from the bacteria in the cell to the anode. Unmediated MFCs emerged in the 1970s; in this type of MFC the bacteria typically have electrochemically active redox proteins such as cytochromes on their outer membrane that can transfer electrons directly to the anode. In the 21st century MFCs have started to find commercial use in wastewater treatment. In May 2007, the University of Queensland, Australia completed a prototype MFC as a cooperative effort with Foster's Brewing, converted brewery wastewater into carbon dioxide, clean water and electricity. The group had plans to create a pilot scale model for an upcoming international bio-energy conference.

Labelled figure





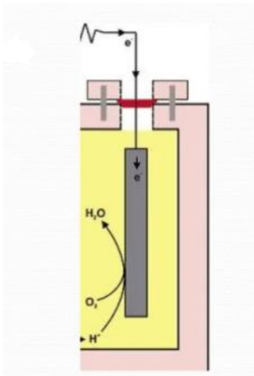
Anode



Anode compartment

- Conductive, bio compatible & chemically stable with substrate
- Stainless steel mesh, graphite plates or rods
- Bacteria live in the anode compartment and convert substrate to CO2, H2O and energy
- Bacteria are kept in an oxygen less environment

Cathode



Cathode compartment

- Electrons and protons recombine at the cathode
- Oz reduced to water
- Pt catalyst is used

Anodic and Cathodic Reaction

- **Anodic reaction:**

  $$\underset{\text{acetate}}{CH_3COO^-} + H_2O \rightarrow 2CO_2 + 2H^+ + 8e^-$$

- **Cathodic reaction:**

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

Applications

MFCs are used in water treatment to harvest energy utilizing anaerobic digestion. The process can also reduce pathogens. However, it requires temperatures upwards of 30 degrees C and requires an extra step in order to convert biogas to electricity. It is also used in,

- Powering underwater monitoring devices
- Power supply to remote sensors
- BOD sensing
- Hydrogen production

- Waste water treatment
- Secondary fuel production
- Bio-Sensors
- Desalination
- Educational too

Advantages

- Generation of energy out of biowaste / organic matter
- Direct conversion of substrate energy to electricity
- Omission of gas treatment
- Aeration
- Bioremediation of toxic compounds

Limitations

- Low power density
- High initial cost
- Activation losses
- Bacterial metabolic losses

Conclusion

- MFCs have been explored as a new source of electricity generation during operational waste water treatment.

Phototropic MFCs and solar powered MFC also represent an exceptional attempt in the progress of MFCs technology for electricity production.

- It can be used for production of secondary fuel as well as in bioremediation of toxic compounds.

However, this technology is only in research stage and more research is required before domestic MFCs can be made available for commercialization

- Provided the biological understanding increases, the electrochemical technology advances and the overall electrode prices decrease, this technology might qualify as a new core technology for conversion of carbohydrates to electricity in years to come