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To Study Microbial Fuel Cell with its Recent Developments

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Abstract: *Microbial Fuel Cells (MFCs) are the special devices which are been used to produce electricity by anaerobic fermentation of organic as well as inorganic matter from easily metabolized biomass to complex wastewater using microbes as biocatalysts. Microbial Fuel Cell (MFC) is a bio-electrochemical catalytic activity of microbes to produce electricity from the oxidation of organic, substrates under natural condition. There is an increasing interest in photosynthetic MFCs designed to harness Earth's most abundant and promising energy source. Despite their MFCs havent yet successfully translated into commercial applications because they demonstrate persistent performance limitations and bottlenecks associated with scaling up. micro scale MFCs have received attention as a singular platform for various applications like powering small portable electronic elements in remote locations, fundamental studies of microorganisms, screening bacterial strains, toxicity detection in water. MFC is a great technology which can be used in the Modern World for generation of electricity and concomitant wastewater treatmentt.*

Keywords: MFCs, Wastewater treatment, Electricity Generation

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I. INTRODUCTION

MFC is a device that converts chemical energy to electrical energy with the help of catalytic reaction of microorganisms which is produced by the oxidation of organic compounds into ATP by sequential reactions wherein electrons are transferred to a terminal electron acceptor to generate an electrical current.

Microbial fuel cells provides new opportunities for sustainable production of energy, in the form of direct electricity biodegradable compounds present in the wastewater, are achieving simultaneous wastewater treatment. MFC consists of an anode compartment where fuel is oxidized by bacteria which generates free electrons H30+. A membrane that separates anode and cathode and allows flow of H30+. Electrons are transferred from anode to cathode through an external circuit.

In MFC, organic matter is oxidized in the anode chamber producing carbon dioxide, protons and electrons are then transferred to the anode surface. From anode, the electrons move to cathode through the external electrical circuit, while the protons migrate through the electrolyte and then through the cationic membrane. Electrons and protons are consumed in the cathode by reduction of soluble electron acceptor, such as oxygen.

II. HISTORY OF MFC

Michael Cressé Potter was the one, who thought of an idea of using microbes to produce electricity and later he initiated the subject in 1911. In his Experiment, he managed to generate electricity from Saccharomyces cerevisiae. in the year 1931 Scientist Barnett Cohen 1, created microbial half fuel cells that, when connected in series, were capable enough to produce over 35 volts with a current of 2 milliamps

After Carrying out a lot of Experiments & Study, the functioning of MFC was Little Clearing Justified in Late 1970s. The concept was firstly studied by Robin Allen and after him the further Studies were carried out by H. Peter Bennetto in the early 1980s, helped in build an understanding of the working principle of fuel cells.

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In May 2007, the University of Queensland, Australia finished a model clean water and electricity. The group had plans to make a pilot-scale model for an upcoming international bio-energy conference MFC as a cooperative effort with Foster's Brewing. The prototype, a ten L design, converted brewery wastewater into CO2.

III. Indian Scenario

India are going to be the fifth largest electricity producer and consumer within the world by 2022, with 1905 TW. Due to its growth of developing countries such as India depends on the generation of energy. Due to the growth of developing countries such as India depends on the generation of energy required for industrial and agricultural sectors, and the energy-use efficiency of their processes. In the current energy crisis it's now a serious concern of governments and researchers to seem for alternative and sustainable sources of energy for the longer term. Fuel cell machineries offer dual-purpose resolutions for electricity generation and wastewater treatment. This review gives insight into the basic functioning of microbial fuel cell (MFC) technology .Due to its low land-to-population ratio, the use of land for production of biofuel producing plants is not a viable option. Wide utilization of renewable resources like solar and wind generation has been introduced and implemented within the policies of the govt of India. The use of green energy is an alternate to fossil fuels, but strategic waste management remains unaddressed in each commercial sector. MFCs are electrochemical devices functioning on metabolic abilities of microorganisms to oxidize organic substances and generate flows of electrons serving the dual purpose of waste management and energy generation.

IV. Literature Survey

Microbial fuel cells have emerged in recent years as a challenging technology. Microorganisms are interacted with the help of electrodes, which are either removed or supplied through an electrical circuit. MFCs are the major type of bio electrochemical systems, which converts biomass into electricity through the metabolic activity of the microorganisms. Microbial fuel cell is n bio-electrical system to generate electrical power through the metabolic products of microbial respiration thus requiring a continual supply of organic carbon for energy. MFCs are typically comprised of anodic and cathodic chambers separated by a proton exchange load connects the two anodic chamber, completing throughout the electron transport chan. Nicotine adenine dinucleotide (NAD) and nicotine adenine dinucleotide dehydrogenase (NADH) function as coenzymes for the reactions, repeatedly oxidizing and reducing to synthesize adenosine triphosphate (ATP), the biological energy unit .Factors affecting the electricity production which influences the metabolic process of bacteria.

The idea of using microbes to produce electricity came up from the early twentieth century. In the late 1970's it was understood how the microbial fuel cells functioned. The concept was studied by Robin M. Alien and later by H. Peter Bennotto, where the people saw the fuel cell as a possible method that helped build an understanding of how fuel cells operate and he was seen by many topics foremost authority.

According to logon et al, aerobic wastewater treatment process takes up about 50% of the energy used in activated sludge process which is approximately 0.6kwh for each cubic meter of wastewater. MFCs have shown to successfully treat wastewater which includes domestic, animal, brewery and food processing wastewaters and generate current in the process.

V. Experimental Setup

A) Construction

a) Components in MFC

The microbial cell consists of straightforward yet vital components to effectively harness the energy are as follows:

- Electrodes – both within the anode and cathode chambers
- Proton Exchange Membrane – (widely used Nafion because the least resistive membrane)
- Substrate – any organic substance to be used as food source for the bacteria
- Bacteria – exoelctrogens, most fitted to MFC applications

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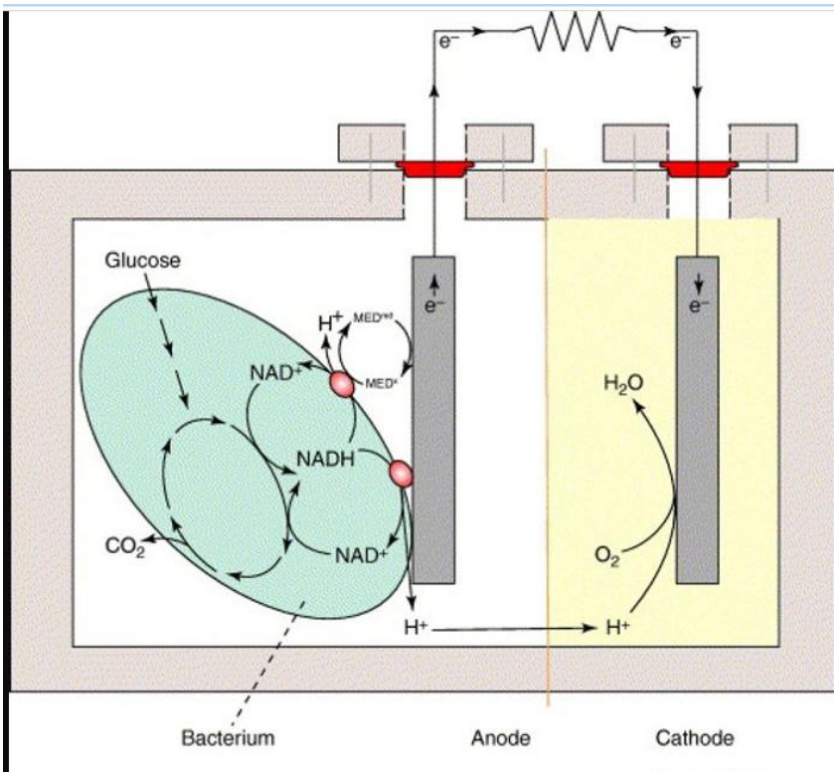
VI. WORKING

MFC's are electro chemical devices that use the metabolic activity of microorganisms, generating current by direct or intervened electron transfer to electrodes. The device contains of an anode chamber, a cathode chamber, electrodes, proton exchange membrane and an external circuit.



Just like a standard battery, an MFC uses energy to get electricity. An MFC has two electrodes which are in two separate spaces. The anode chamber that contains the bacteria is anaerobic. This means that it does not contain oxygen. The cathode chamber is aerobic. That means it does contain oxygen. The oxidation process occurs inside the bacteria living within the anode chamber. This takes advantage of the oxidation that bacteria perform naturally during respiration. Electron bonds hold together the molecules within the food that bacteria eat. The bacteria disrupt those bonds to discharge the electrons.

Cellular respiration can continue for as long because the bacteria have food. Bacteria can digest pretty much anything. They can digest human waste. They can also digest other waste products like ammonia, ethanol, or acetate. This makes MFC technology really attractive. It can generate electricity and obtain obviate waste at an equivalent time. Generating electricity using bacteria isn't a replacement idea. But MFC still generate relatively low currents.

A) Anode Reaction

$$C_{12}H_{22}O_{11} + 13H_2O \rightarrow 12CO_2 + 48H^+ + 48e^-$$

B) Cathode Reaction

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

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VII. CONCLUSION

The world fronting problems like global warming and climate change, using of carbon-based fuels has to go down and we have to make way for the usage of increasingly renewable sources for energy generation. Thus using technology like MFC will be very useful.

Microbial fuel cells does provide various advantages. Not just with electricity generation but also with wastewater treatment. It only requires microorganisms and electrodes for its process which really helps with cost efficiently.

Provided the biological understanding increases and the electrochemical technology advances and overall prices of prices of electrode decrease, this technology might just be eligible as a new staple of technology for generation of electricity and waste treatment.

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