Review on Generation of Electricity from Organic Waste

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Abstract

Today we are witnessing a global energy crisis due to huge energy demands and limited resources. Non-renewable energy resources are depleting and renewable energy sources are not properly utilized. There is an immediate need for search of alternate routes for energy generation. Already many type of fuel cell present which produce electricity or energy. But the MICROBIAL FUEL CEEL is a device in which energy produce by waste. Waste like any type of waste soil waste, water waste, home waste etc. In MFC microorganism to transform chemical energy of organic compounds into electricity is considered a promising alternative. This device is collection of all science field which we done up to this level like physics , chemistry , mathematics , environmental science , microbiology .

Keywords: *Microbial Fuel Cell, Anode, Cathode, Proton Exchange Membrane,*

Introduction

Fuel cell is a device which convert the chemical energy in electrical energy. The macenisum of Microbial fuel cell is same as normal fuel cell but the MCF is a special type of cell. Microorganisms and bacteria used to produce electricity. MCF is a two chamber system in one side is anode and other side is cathode which separate by proton exchange membrane (salt bridge). The current is produce by flow of electrons. Electrons produced by the bacteria from these substrates are transferred to the anode (negative terminal) and flow to the cathode (positive terminal) linked by a conductive material containing a resistor, or operated under a load (i.e., producing electricity that runs a device)[1]. Electrons are transfer from anode to cathode by membrane. Microbially catalyzed electron liberation at the anode and subsequent electron consumption at the cathode, when both processes are sustainable, are the defining characteristics of an MFC.

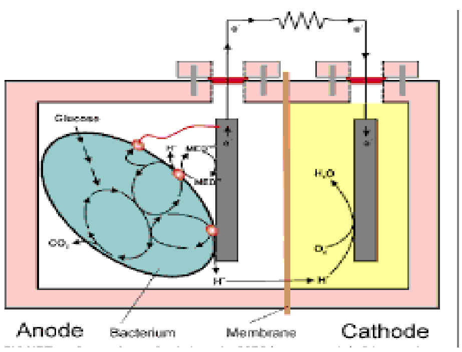


Figure 1

Figure 1 Shows that the electron produce at anode (oxidation) is transfer through proton exchanger to the cathode (reduction). During production of electron also produce a protons which is balance by the anion which produce at cathode side[1].

An early Twentieth century botany professor at the University of Durham, M. C. Potter, first came up with the idea of using microbes to produce electricity in 1911.

While Potter succeeded in generating electricity from E. coli, his work went unnoticed for another two decades before Barnet Cohen created the first microbial half fuel cells in 1931. By connecting his half cells in series, he was able to generate a meager current of 2 milliamps. By 1999, researchers in South Korea discovered a MFC milestone. B.H. Kim et al developed the mediatorless MFC which greatly enhanced the MFC's commercial viability, by eliminating costly mediator chemicals required for electron transport. Microbial fuel cells have come a long way since the early twentieth century[2] . MFC has the capability of production of the maximum power of 6.73W/m^2 and is a cost effective process.

Many different configurations are possible for MFC . A widely used and inexpensive design is a two chamber MFC built in a traditional “H” shape, consisting usually of two bottles connected by a tube containing a separator which is usually a proton exchange membrane such as Nafion , Ultrex or a plain salt bridge . The key to this design is to choose a membrane that allows protons to pass between the chambers (the CEM is also called a proton exchange membrane, PEM)[1] as shown in fig.

H-shape systems are acceptable for basic parameter research, such as examining power production using new materials, or types of microbial communities that arise during the degradation of specific compounds, but they typically produce low power densities. The amount of power that is generated in these systems is affected by the surface area of the cathode relative to that of the anode and the surface of the membrane . The power density produced by these systems is typically limited by high internal resistance and electrode-based losses (see below). When comparing power produced by these systems, it makes the most sense to compare them on the basis of equally sized anodes, cathodes, and membranes.

Anode

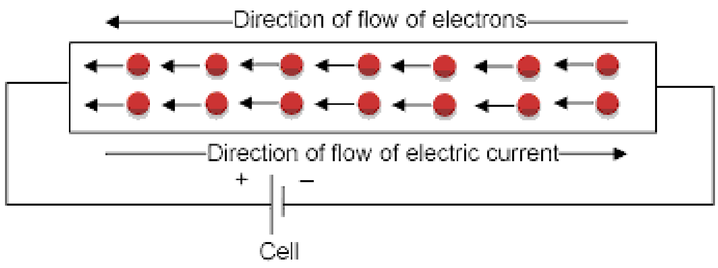
In microbial fuel cell we used the microorganism waste as a anode. This found inside the digestive system of animals, in the ocean and fresh water, in compost piles (even at temperatures over 130°F), and in soils. Although some kinds of bacteria live in flooded soils without oxygen, most require well-aerated soils. In general, bacteria tend to do better in neutral pH soils than in acid soils[3].Anode having a negative charge . The glucose as a catalyst is inject in the microorganism waste due to glucose the growth of bacterial is increase. The bacteria on the anode decompose organic matter and free H+ ions, electron and CO_2 [3]. The electron is transfer from anode to cathode through proton exchange membrane.

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

Cathode

Water is a most important part of our life. It also play a important role in chemical reactions. Water is used as a cathode in microbial fuel cell. Water is used as a cathode because we know that in waste H+, CO_2 and electron is produce and the water having a hydrogen ion and oxygen ion. The H+ which produce in a anode is come into the cathode by proton exchange membrane is combine with the O- (oxygen) become water .

In cathode and anode one-one electrode is placed. The material of electrode is iron or a copper. We prefer copper wire because of iron react with water corrosion is occur. The direction of flow of electron is negative to positive and the current of electricity is flow in opposite direction (positive to negative) as shown in fig.



Reaction:
$O_2+4e^-+4H^+ 2H_2O$

Proton exchange membrane

In a fuel cell the proton exchange membrane is used for transfer the ions. The membrane may be a Nafion , Ultrex or a plain salt bridge. We used a salt bridge in this cell. The shape of salt bridge is usually is U shape. In other cell the salt bridge containing a agar –agar solution. But is MFC we used

NaCl in salt bridge. The purpose of a salt bridge is **not** to move electrons from the electrolyte , rather it's to maintain charge balance because the electrons are moving from one-half cell to the other.

Other substrates used and the amount of power

Different substrates are used in fuel cell and the amount of power is produce is different. The amount of power is depend on the activity of substrates

Substrates	Power produced in mA/cm^2
Acetate	0.8
Arabitol	0.68
Azo dye with glucose	0.09
Carboxymethyl cellulose	0.05
Cysteine	0.0186
1,2-Dichloroethane	0.008
Ethanol	0.025
Furfural	0.17
Galactitol	0.78
Glucose	0.70
Glucuronic acid	1.18
Lactate	0.00
Mannitol	0.58
Phenol	0.1
Propionate	0.035
Ribitol	0.73
Sodium formate	0.22
Sorbitol	0.62
Starch	0.62
Sucrose	0.19
Xylitol	0.71

Application of microbial fuel cell

1. electricity production
2. Biohydrogen production
3. waste/ Water treatment
4. Biosensor

Electricity production: The chemical energy in the organic compounds can be converted to electrical

energy by MFCs. Chaudhury and Lovley reported in a study that R. ferrireducens could produce electricity with an
electron yield as high as 80%. Higher electron recovery as electricity of up to 89% has also been reported[4]. Biohydrogen: Modified MFCs can be used to generate hydrogen in higher amount instead of electricity. The protons are released from the anode chamber transfer to cathodic chamber where it combines with oxygen and form water under normal condition. Although generation of hydrogen from the microbial metabolism is thermodynamically not favourable, an external potential can be applied in MFC circuit to overcome this thermodynamic barrier. In this mode, hydrogen will produced from protons and electrons produced by the anodic reaction once combined at the cathode[4]. Waste treatment: The MFC bioreactors were considered to treat waste water in the year 1991. Wastewater contains a wide range of organic compounds that can be used by the microbes in a MFC. The amount of electricity produced by MFCs in wastewater treatment protreatment process. MFCs yield 50–90% less solid deposition. Furthermore, complex organic molecules such as acetate, propionate and butyrate can be thoroughly broken down to simple CO2 and H2O[4]. Biosensor : MFC is not only used for power generation , they can also be used as convenient biosensor for waste water streams. wasterwater is evaluate on the based on the amount of dissolved oxygen required by aerobic bacteria to breakdown organic contaminants present in body of water this value is called bio-chemical oxygen demand value(BOD) and also perform well for chemical oxygen demand (COD)[4].

Conclusion

The achievable power output from MFC has increased remarkably over the last decade, which was obtained by altering their designs, such as optimization of the MCF configurations, their physical and chemical operating conditions, and their choice of the biocatalyst.

Although some basic knowledge has been gained in MFC research, there is still a lot to be learned in the scaleup of MFC for large scale application.

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