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Microbial Fuel Cell from Industrial Waste

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ABSTRACT

Microbial fuel cells (MFC) produce electricity by using microorganisms. It is a bioenergy technology with maximum efficiency with minimum cost. Microbes produce energy which depends on several factors, such as, power output and coulombic efficiency, MFC design, anodic chamber MFC, and operating conditions. In this study, we investigated the configuration and various applications of MFC.

KEY WORDS: MFC, generation of Electricity, Industrial waste.

1. INTRODUCTION

Microbial fuel cells (MFCs) offer an alternative source of electricity from waste and other source. It can be also used as a tool for hydrogen production, bioremediation and biosensors. Power can be generated from biodegradable biomass. MFC can function with or without the help of mediators; these mediators are used to transfer the electrons. Microbial fuel cells use bacteria to generate electricity by mediating the oxidation of organic compounds and transferring the resulting electrons to an anode electrode. In MFC, microorganisms undergo oxidation reaction in anode and produce protons and electrons. The electrons are attracted to anode and through an external circuit it is transported to cathode. The protons are reacting with oxygen in cathode and water is produced. Thus in anode, microbes are generating electricity by producing electrons and protons in anode. As an oxidized product, carbon dioxide is produce, and electricity will produce as by-product. Thus anaerobic chamber is needed to generate electricity by microorganisms.

The reactions in electrode are

Anodic reaction: $CH_3COO^- + 2H_2O \longrightarrow 2CO_2 + 7H^+ + 8e^-$

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

The substrate source degraded into CO_2 and water, with this, electricity generate as a concomitant product. The electron flow from anode to cathode through an external circuit will produce electricity, thus the production of electricity by MFC depends on the electrode pair used. As microbes are producing electric power, MFC cells can also called as biofuel cells. In cathode, a reduction reaction starts, where electrons produce water from oxygen. In 1911, Michael C. Potter explored bioelectricity potential, built the first MFC. In case of MFC, the conversion potentiality from substrate to electricity is highly significant (up to 96%), but the transformation rate is lower, thus these technology has the only limitation. One MFC can produce 1 volt in open circuit values under special conditions [8] where the theoretical value shows 1.14 V. The industrial wastes are the rich source of organic product which can be utilized by the microorganisms and can generate electricity. Simultaneously the industrial waste can be treated. The present study we reported the different design and application of Microbial fuel cell which depends on the power production by the microbes isolated from the effluents sample.

Microbial fuel cell configuration:

One- Compartment MFC systems: The simple form of MFC consists of a cathodic chamber and an anodic chamber which is partitioned by a proton exchange membrane. In this type of MFC, cathode is exposed directly to the air, so this system reduces the use of cathode.

MFC with Two-Compartment systems: In the two-compartment MFCs, that functions in batch mode there is a defined medium such as glucose or acetate solution to produce energy. This type of MFC consists of a cathodic chamber and an anodic chamber and both are joined by a salt bridge, or a PEM. These permit protons to transfer across to the cathode while blocking the diffusion of oxygen into the anode. The compartments can be used in different practical designs.

Stacked MFC: When several MFCs are joined in series or in parallel, it makes stacked MFCs. In stacked position, either in series or in parallel, generation of electricity will be increased. In stacked MFCs, the parallel arrangements function much more higher than the serial MFCs. This implies that the connecting the MFCs in parallel than in series shows higher maximum bio-electrochemical reaction rate.

Application of MFC

Electricity Generation of electricity: 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.

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 process can significantly reduce the electricity to be generated in a conventional treatment 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 CO_2 and H_2O.

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.

2. CONCLUSIONS

Microbial fuel cell has potential to produce the high amount of electricity using waste. Different types of microorganisms are capable of degrading the waste with transfer of electrons to a MFC electrode. Therefore, MFC is an eco-friendly, economical, reliable system for power generation.

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