International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Review Paper on Microbial Fuel Cell Technology in Sewage System

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A B S T R A C T

Renewable sources of energy like solar, geothermal, wind, tidal energy etc. are primarily used for sustainable development. They also have unavoidable limitations like weather conditions, installation cost and so on. Sewage waste is an untouched source, which might yield power by overcoming the characteristic drawbacks of different renewable energy sources. A resolution is being developed to tap these unobserved and untapped wastes as an energy resource. Based upon the principle of microbial fuel cell technology a sewage cell is developed to tap sewage sludge for generating power. This system does not occupy large space, and it is simple and compact in construction.Thus, sewage cell is easily accessible to remote areas as it does not require any huge land resources or high-end technologies unlike existing Power plants.

Keywords: Fuel Cell, Copper Sulphate, Sewage Sludge, Graphite Coated Cylinder, Proton exchange membrane.

1. Introduction

Use of the fossil fuels can trigger global energy crisis and increased global warming, hence there is considerable interest in research network on green production. In a period of climate change, alternate energy sources are desired to replace oil and carbon resources. Subsequently, climate change effects in some areas and the increasing production of biofuels are also putting pressure on available water resources. Microbial Fuel Cells have the potential to simultaneously treat wastewater for reuse and to generate electricity; thereby producing two increasingly uncommon resources. Microbial fuel cell technology represents a new form of renewable energy by generating electricity from what would otherwise be considered waste, such as industrial wastes or waste water etc.

2. Microbial Fuel Cells for Waste Water Treatment

Microbial fuel cell technology can be defined as a bio-electrochemical system in which microorganism's function as catalysts to convert chemical energy (organic waste) into electrical energy.Microbial Fuel Cells can produce energy directly from biodegradable matter waste such as sugars, organic acids and

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biomass. The base inspiration of this concept of microbial fuel cells comes from the process of cellular respiration which is a collection of endothermic metabolic reactions that convert nutrients into Adenosine Triphosphate (ATP) which fuels cellular activity. In this system a proton exchange membrane is used which helps to generate electricity [1].

3. Construction and its Working of MFC's

In microbial fuel cells, it consists of two electrodes (anode and cathode), proton exchange membrane. The anode electrode is immersed in a sewage waste, whereas the cathode electrode is get separated from the sewage sludge. The Proton exchange membrane is placed between these electrodes which play a vital role in Microbial Fuel Cells (MFC's). After some time, Bacteria formation occurs in a sewage waste. The bacteria formation in a sewage waste at anode reduce the organic matter and oxidize it. Then it forms a redox reaction. Finally, protons generated at anode due to microbial activities pass through the membrane to reach cathode and the electrons pass through the anode to an external circuit to generate a current [2].

4. Construction and its Working of MFC's

In Microbial Fuel Cells (MFC's) the proton exchange membrane plays a vital role for electricity generation. So, choosing out a semi permeable membrane is more important. The study investigates that, the use of two low cost membrane materials such as natural polymer (eggshell membrane), and a synthetic polymer (polydimethylsiloxane, PDMS) helps for electricity generation in Fuel cells. And then for speed up the movement of electrons from cathode to anode a hollow fibered nano materialis used as Proton Exchange Membrane (PEM) [3]. A salt bridge is also used for the transfer of protons instead of sophisticated membrane. This reduced cost and complexity [1].

5. Construction and its Working of MFC's

The author claims that proton exchange membrane and electrode surfaces are the factors that affect electricity generation in Microbial Fuel Cells (MFC's). The size of electrodes is also important because if Increase in size of electrode, then the electricity generated in this system are also increased. This occur mainly due to internal resistance. If surface areas of the semipermeable becomes smaller than the electrode, then power output will be limited. In order to make the electrodes to become high in ionic strength, then the electrodes are immersed in certain solutions such as ferricyanide solution. By doing all these step helps increase in power output [4].

6. Analysis of Carbon Cloth and Aluminium Electrode

A study comparative Analysis of Carbon Cloth and Aluminium Electrodes Using Agar Salt-Bridge Based Microbial Fuel Cell for generation of electricity in a sewage sludge are done. A two setups are made and have been tried to check the different possible outcomes with carbon cloth and aluminium mesh as electrodes. Both results are recorded, carbon cloth shows a voltage of 540mV, while Aluminium mesh shows a voltage of about 400mV.In this method, the carbon cloth gives out a continuous generation of electricity, whereas the aluminium mesh gives out some alternation in electricity generation **[5].** Ammonia gas treatment of a carbon cloth anode are also increase the surface charge of the electrode and Microbial Fuel Cells (MFC's)performance. By immersing the anode in a phosphate buffer solution causes increase in ionic strength which increase the power output **[6].**

7. Single and Double Chamber Microbial Fuel Cell (MFC's)

Single-chamber MFC contain a small volume which can hold few milliliters, more often up to 30mL. But these MFCs are more power efficient than large ones. Therefore, it is easy to design tiny MFCs that can be stacked together for electricity generation. In this specific design, the anode is put on one end whereas the cathode is placed on the opposite end where a hole is drilled to allow the passage of oxygen. There are two opening at the top to allow for the filling and draining of the substrate, they have also tight stoppers. It is important to mention that single chamber fuel cells do not need a PEM in general **[7].** In double chamber MFC's both electrodes are separated by Proton Exchange Membrane. This type of MFC's are widely used as it has high volume, therefore it generates more electricity **[8].**

8. Design of Microbial Fuel Cells for Applications

The design of Microbial Fuel Cells involves various parameters. Recent designs which are widely consider are about Flate plate and Tube flow system. In this Flate plate consists of a rectangular anode chamber with proton exchange membrane kept between anode and cathode. These electrodes are made of granular graphite, carbon paper and titanium plate. in this method the space between anode and cathode are quite low.Thus, electricity generations occur much higher, whereas tube flow designs are quite complicated and the distance between anode and cathode are larger, so generation of electricity limited**[9].**

9. MFC's Methodology and Technology

Microbial Fuel Cell have certain parameters and steps which are mandatorily followed, first the anode, cathode setup is made then the setup is immersed in a solution for few hours to increase the ionic strength. Then the setup is immersed in a sewage sludge. After some time, corresponding voltage and current are obtained which are measured by using multimeters. Voltage and current will be varying with time. Various calculations regarding the efficiency of power losses are also need to be taken. Microbial Fuel Cells design plays a vital role in market before it moves upon to sales and services which are scaling up for wastewater treatment plants. In cost aspects electrode selection and increase in voltage output are major concern. Designs are made to build up with multiple cells to raise up the voltage output.

10. Conclusion

Microbial fuel cells represent a new promising technology that gives hope to the future generations. We were able to build and assess the performance of different MFCs by maintaining their double chamber shape and alternating the electrodes materials while trying different substrates. We showed that the usage of different types of electrodes is more efficient than using the same material. Carbon can be used at the anode while aluminum with a higher surface area than the anode is to be used at the cathode. We did also observe that natural garden soil could be used instead of the sewage wastewater; it delivered both higher power and electric potential. In terms of scale-up, we tried the series combination of two MFCs to amplify the power and the electricity generated. Similar to electric generators, the potential of both MFCs adds up and the current increases significantly. It has been previously proven that small-scale MFCs are more efficient than large ones. Therefore, we need to build miniaturized MFCs and construct a stack that is able to generate useful power.

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