Critical Review on Generation of Electricity from Waste by Microbial Fuel Cell Technology

Mr. Akshay D. Prabhu[1], Mr. Ashwin D. Pathak[2]

[1]Department of Electronics Engineering,
Thakur College of Engineering & Technology, Mumbai, Maharashtra, India
sujataprabhu87@gmail.com
[2]Department of Humanities &Sciences,
Thakur College of Engineering & Technology, Mumbai, Maharashtra, India
ashwinpathak.pathak@gmail.com

Abstract: ***Energy is the lifeblood of the society and to harness energy in a clean and green way, the scientist all over the world is exploring for the newest techniques and procedures The energy production is extremely dependent on the fossil fuels, but these non – renewable sources are extremely limited in quantity and so the entire world is shifting from*** non ***renewable energy sources to renewable energy sources. The outgrowth of the non conventional sources of energy is not completely a matter of industrial interest, but also it is a matter of scientific inquiry. Regarding this aspect, this paper discusses the generation of electricity from waste. This paper focuses on generation of electricity from organic waste and, it also discusses the parameters affecting the efficiency of the microbial fuel cell which are the only converters of waste to electricity. The paper just enhances the concept of waste to wealth logic where electricity is the wealth we obtained from waste. Generation of electricity from waste is the need of the hour and if this technology gets popularized then surely the energy deficiency can be reduced to a greater extent.***

Keywords: Biocathodes, bioenergy, microbial fuel cell, extracellular.

1. Introduction:

The ever rising population of humans has played a major role in the increase in the demand for energy consumption throughout the world. The major energy providers present in the marketplace at the present scenario are the fossil fuels. But the limitation of the fossil fuels is their finiteness in quantity. And then the full world is shifting from non renewable energy sources to renewable energy sources. The outgrowth of the non conventional sources of energy is not completely a matter of industrial interest, but also it is a matter of scientific inquiry. Usage of available wastewater for the generation of hydrogen is attaining attention as an origin of alternative energy method for holding the cleaner fuel [1-11]. The total quantity generated waste in India is segregated as 55% of the waste is comprises of organic matter, 15% are the recyclable waste and 30% is the residual waste [13, 14]

The facts and figures clearly indicate that the main portion of the waste generated is organic in nature. According to the World Bank report, the Municipal Solid Waste [MSW] is about to double by the year 2025 and the pace of urbanization also affects the quantity of waste generated [15].

Figure 1: Composition of Waste in India Chart [13,14]

Immediately the question springs up what to do about the waste that is generated? And so the principle of 3R's that is Reduce, Reuse and Recycle comes into the picure, but this rule is also not applicable to all the categories of waste. The accumulated waste should be used in such a manner that neither the waste remains nor does; it leads to some other problem like environmental contamination. Waste Management is also practiced by burning the waste which leads emission of gaseous contaminants into the atmosphere or dumping the waste. In such processes we not only eliminate the waste, but also we contaminate our environment. So the best way to eliminate the waste and to conserve our environment is the use of microbial fuel cell. Use of microbial fuel cell enables us to obtain bioenergy from the waste [16, 17]. Microbial Fuel Cell [MFC] is a promising technology, which assures the conversion of the biomass into electricity. These biological batteries use the microbial metabolism for the generation of electricity from biomass [18-21]. As compared to other bioenergy conversion processes like gasification, fermentation, anaerobic digestion, etc., MFCs are advantageous as they involve less sludge formation, and a cost effective process as they can be operated at ambient physical conditions [22, 23]. MFC technology has created a fresh hope in scientific community for the genesis of the electricity from waste which helps in reaching two goals at a time, one of the energy generation and the other of waste elimination. MFC can be well used to get electricity from the waste water, oceanic sediments and biomass [24-26, 78]. The main principle involved in the MFC working is the usage of an innate bacterial respiratory process which involves the extracellular electron transfer [27-29, 76]. MFC can be utilized for the nitrate reduction from the water resources like waste water, dry land, water or synthetic waste water [30-34]. The basic diagram of the MFC is represented in the figure 2. In the figure a proton exchange membrane [PEM] is present, which divide the anodic and the cathodic compartments. There are lids numbered 1 which seals the anodic and the cathodic compartment. This report basically focuses on the parameters affecting the efficiency of the functioning of MFC.

2. Effect Of Anode On MFC:

Microorganisms play a significant part in the anode chamber. As noted earlier, the electric current is formed due to the extracellular electron transfer and this process, thus results in the organic waste removal [35, 75]. The bacteria available in the anode chamber function as the effective catalyst in increasing the activation energy required for the reaction to proceed in the forward direction [36-39].

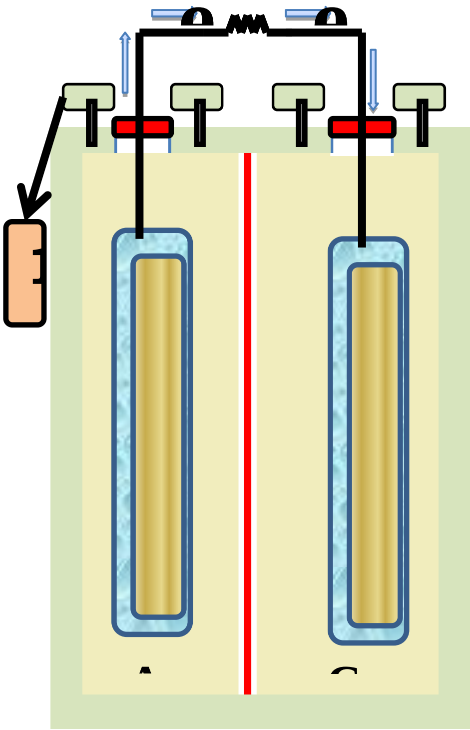

Figure 2 Schematic Illustration of MFC [75]

The principle job involved is the amplification of the anodic microbial electron transfer with the utilization of electron mediators or optimizing the system design and the electrode design [40-42]. The growth in the surface region of the electrode eventually improves the force generation capacity and in this aspect carbon nanotubes are believed to expand or increase the electron transfer feasibility [43]. Chemically stable polymers like PTFE are proven to boost the bioenergy production when the Escherichia coli were used as the active biocatalyst in the reaction and the power density obtained is 760 mW/m^2 [44].

3. Effect Of Cathode On MFC:

The result of the different cathode on the generation of voltage can be presented in the accompanying graph.

Oxygen is the final electron acceptor at the cathode. But the activity at the cathode can be increased with the aid of a Biocathode. A Biocathode is one in which a flimsy film of microbes is present at the cathode which increase the electrical productivity of the MFC and thus increases the efficiency of the entire MFC system [51-54].

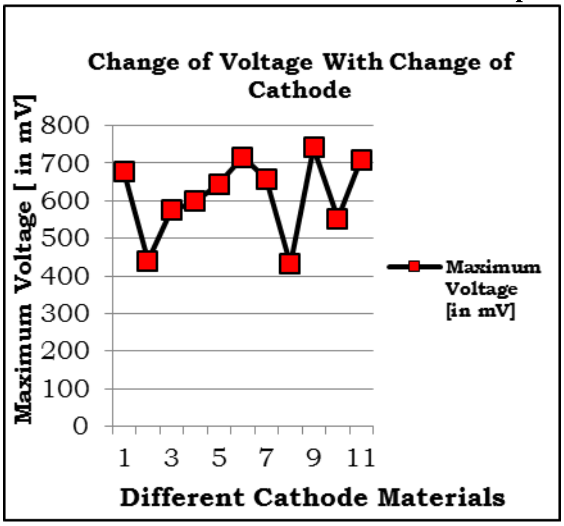

Figure 3 Graph of Change in Voltage v/s Different Cathode Materials[45-49]

Table 1: Names of Cathode Material [45 -49]

Sr. No.	Cathode
1	**Activated carbon fiber felt (ACFF) [45]**
2	**Air–cathode with graphite [46]**
3	**Carbon felt [45]**
4	**Plain carbon [45]**
5	**Pt-coated carbon paper [45]**
6	**Tubular ACFF [45]**
7	**ACFF granules (1 cm) [45]**
8	**Biocathode [47]**
9	**Graphite felt [48]**
10	**Parallel sheets of carbon paper secured by carbon fiber coated with Pt [49]**

The utilization of Biocathode also helps in the handling of waste water by the microbes present in the cathodic area. Biocathodes not only does reduce the cost of the Cathodic material, but also aids in the efficient removal of the byproducts formed in the reaction by the cognitive operation of microbial metabolism [55]. The usage of oxidizing agent in MFC has the opportunities to increase the electrical power which is brought forth by the MFC [56].

4. Use Of Ceramics In MFC:

Ceramics extend its applications to the treatment of the residual water as they tend to convert the contaminants to non toxic materials and thus the residual water gets treated [57]. The cathode made up of the ceramic material is proven to increase the performance of the MFC and also there was a sharp increase in the power curve observed [58, 59]. It is also reported the membrane made up of ceramic material is proven to enhance the efficiency the cell. The use PEM in the cell led to an increase in the cost of the cell and thus the ceramic provide a cheap alternative for such costly membrane [60-65].

5. Limitations And Solutions:

Though microbial fuel cell has the ability to generate the electricity from the waste, but there is no commercial touch which given to these cells. The major hurdle which inhibits the intensification of the fuel cell on a large scale includes the price of the materials and the other difficulties which are present in the large scale models [66]. In the current MFC models the electrodes are made up of expensive materials like platinum, silver. Platinum is used as the cathode material to enhance the oxidation of the oxygen at the cathode [67-69]. Another major drawback associated with the MFC their low power generation as compared to other available renewable sources of energy [70]. It is likewise noted that the bearing of the protozoa decreases the current production rate of the MFC [77]. The problems associated with MFC scale up can be dealt with the principle of lowering the size of each MFC and then connecting these smaller units to form a pile of such cells. The major benefit achieved by the miniaturization of the MFC is the lowering of the electrode distance, an increase in surface area to volume ratio and also enhancement in the generation of the electricity [71-73].

6. Conclusion:

The diminishing nature of the fossil fuel resources has led to a hunt of any renewable source of energy which has the propensity to resolve the energy crisis scenario. In this aspect, MFC is an attractive option for the energy production, though it has some drawbacks. Drawbacks or limitations are connected with every system, but optimization of the system is must to achieve the desired result or outcome. In the same way MFC provides the best clean and green alternative for the treatment of the waste and also to produce the electric power from it. It is the best example of the waste to wealth logic as it helps us to achieve two aims in one process that is treatment of the waste and power generation. Though MFC has the low power production till date but they are a newer technology and therefore the scientific inquiry is extended out across the globe to make the MFC system an efficient one.

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Author Profile

Mr. Akshay D. Prabhu: A young mind in the area of engineering currently pursuing his B.E (Electronics) from Thakur College of Engineering & Technology. He completed his grade tenth and twelfth examination from Guardian School and was school and college topper respectively in both these examinations. His board of education was ICSE and ISC for the grade tenth and grade twelfth examination respectively. Presently in the month of March, his first paper got published in the International Journal of Mechanical Engineering and Robotics. He presented a paper in State level Technical paper Presentation Contest held at Pune and secured second position in the Maharashtra State. Research is the field which interests him and is currently working on a project on extraction of hydrogen from urea rich agriculture waste.

Mr. Ashwin Pathak: An inspiring mind in the field of mechanical engineering completed his B.E (Mechanical) in 2008 and completed his post graduation in Mechanical Engineering and obtained his M.E. Degree in 2015. He has guided more than 30 minor projects and has six years of teaching experience. He worked for one year in the fire industry as a project engineer. He has his publications in International Journal, National journal & International Conference. Currently, he is working as an Assistant Professor in the Humanities & Sciences Department of Thakur College of Engineering and Technology, Mumbai, Maharashtra.