Development of Microbial Fuel Cell as a Contribution to Renewable Energy Sources

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Abstract: ***Renewable energy plays an important role in future energy planning. Due to the changes in environment, shortage of fossil fuel, increase in carbon foot printing and the rising demand of sustainable energy generation there is a need of new energy generation resources and research. Hence, the main aim of proposed research is to develop microbial fuel cell for clean energy generation. There is a need of alternative energy sources with less cost to meet the future energy demands. Also, the waste management is a bigger issue around the globe. As Microbial Fuel Cells (MFCs) are less expensive and are with zero carbon foot printing it is considered as an emerging clean and alternative mean of energy generation. Also, the waste management is becoming important issue. To utilize waste material for energy generation is possible with bacteria present in waste material. The proposed research tested microbial fuel cell for household waste with use of carbon cloth electrodes. This paper presents the microbial fuel cell processes for different types of waste materials and pilot project execution is successful in terms of energy generation. The aim of the development of duel chamber microbial fuel cell is to contribute to the household electrification at pilot project level and further to that analyze the feasibility for future enhancements. The paper discusses the detail execution methodology for efficient use of waste materials in semi-solid and liquid form. The proposed research will be very useful as a source of renewable energy. More precisely, in future it is possible to generate independent household electrification with such options.***

Index Terms**: *IoT, QoS, Risk engineering, IoT device, MQTT***

I. INTRODUCTION

Electrical energy is important building block of present day the community. The impact of fossil fuel is the core cause of carbon foot printing and global warming. The fuel shortage is other threat to energy generation capacity [1]. The existing options for generation of clean energy are pv panels, utilization of geothermal heat, windmills for energy production etc. The benefits of renewable energy are it is less expensive, harmless to environment and there are no negative impacts on environment like fossil fuels [2, 3, 4]. The existing research revealed that bacteria can be used for energy generation which may be used in microbial fuel cells. In a MFC, microorganisms oxidizes a base material are stored which are segregated by the membrane call as proton exchange membrane (PEM) [5]. Electrons move from the micro organism to the electrode through the exact holding chamber and so through a electrical circuit to the cathode exactly where these incorporate with the protons as well as , air to develop water. The discrepancy in the potential paired to electron flow generates electrical energy. Electrons produced by bacteria by using the anaerobic oxidation process of biological mean are transferred to respiration semi-solid material. Fabricated electron carriers or high concentrations of acids can utilized to hold electrons from inner side of the cell to an outward electrode [6]. Then again, the demand for excessive union of electron providers, several of which usually are harmful chemical substances, is believed to produce energy in a huge level in a membrane used fuel cell is become improper. Several microorganisms can certainly generate their particular mediators which usually get rid of the need to have mediators.

A microbial fuel cell is simulation of a scientific procedure in which usually microorganisms do not really immediately transmit the developed electrons to their particular feature electron acceptor [7]. Rather, the transfer method is consequently executed through an anode, a resistance and then a cathode. Hence microbial energy levels are straight transformed to electric energy. Analysis on microbial fuel cells was given greater focus as a ways to develop renewable energy from all-natural substrates, like glucose [8, 9]. Even so, use of the technology, for normal uses continues to be low pertaining to problem of expense of anode and the cathode chambers and considering that the difficulty in transmission with the aid of the PEM. The various other categoriesprovide reasonably limited points of views for municipal practice mainly because of the poor variants of electron subscriber in sediments [10, 11].The part of microorganisms in microbial fuel cell is usually extremely essential. Some organisms cannot transfer the electron to the anode, and consequently mediators as methyl possess to become utilized to help the electron transfer. Nevertheless, latest advancement offers demonstrated that there can be found electrochemically energetic bacteria which can transfer electron straight to the electrode without mediators [12].

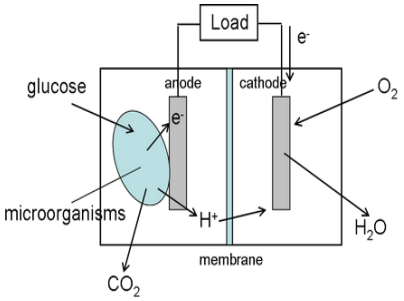

Figure 1- Representation of microbial fuel cell [12]

From Figure 1, we can see that the bacteria in MFC convert the biomass substrate straight into electrical energy, while in the biogas fermentation technique; biomass substrate is usually degraded into ultimately the combination of chemical substance fuels.

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Consequently, suitable types of organisms utilized in MFC are extremely important as they identify the real mechanism of the oxidation process response because system of electron transmission in the anode component of the fuel cell, which in turn will impact how efficiently we can get electric energy levels via this procedure.

II. PROPOSED METHODOLOGY

The proposed research methodology is an experimental development. We considered the waste material (avoided solid state materials) which can be decomposed by natural means. As shown in figure 2 below, the participated blocks for the chemical synthesis is executed. The input waste material is placed in main chamber which is separated by membrane. The cathode and anode are placed in each compartment of chamber and power testing circuit is connected to both anode and cathodes by means of probes. The setup is kept for 50 hours for pilot analysis as a single Microbial Fuel Cell (MFC) unit test.

A. Block Diagram

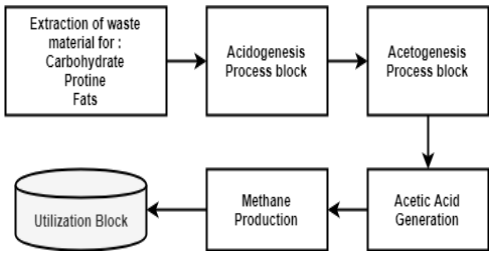

Figure 2–Block diagram of chemical stages of MFC

B. Flowchart

Generally, the MFC participated in two phases: pre-processing and post-processing. The first phase is to filter the waste material in terms of removal of solid entities from raw input material. And second phase is to manage/store generated energy. Between these two phases, the actual MFC processes (chemical synthesis) are involved which are shown in figure 2.

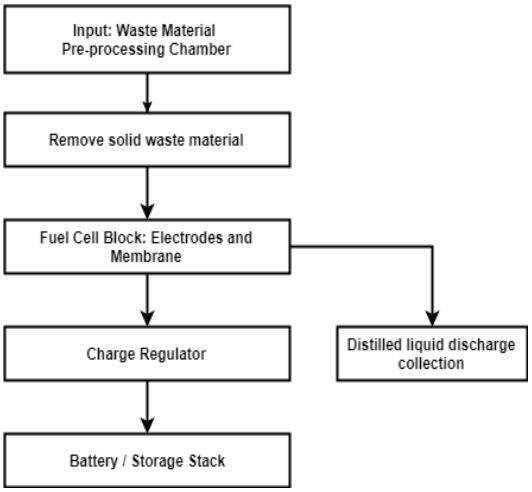

Figure 3 - Proposed Microbial Fuel Cell Process Flowchart

The chemical synthesis carried out in fuel cell block as shown in above figure 3. The cathode and anode used in proposed research are carbon cloths and membrane is used to support the transfer of (+ve and -ve) electrons for energy generation. The power testing circuit is connected using cathode probe on one side and anode probe on other side. For testing of real-time high power output we will use the land pit and copper anode/cathode material.

III. RESULT ANALYSIS

The proposed model of microbial fuel cell is tested with three types of materials: Waste food, Sewage water and household wastes.

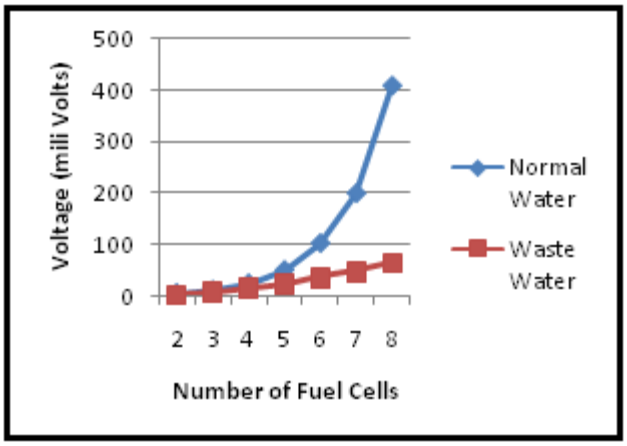

Figure 4- Microbial Fuel Cell Performance Graph

.Further, 2, 4 and 8 MFC units are tested for 100, 300 and 500 hours of decomposition. The analysis results are shown in figure 5 and figure 6.

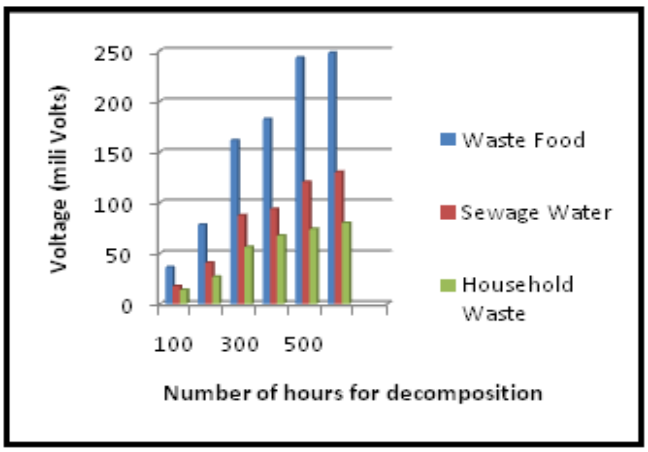

Figure 5- Microbial Fuel Cell Performance for different waste materials

The results shown in table-1 depict that as number of MFC unit increases, the percentage power output increases. There is also effect of temperature on power output but we kept temperature constant. The existing styles for membrane-less MFCs are developed particularly for constant sewage solution. Two types of MFCs have therefore much been utilized: pilot testing systems mainly applying substrates and MFCs developed to pick energy levels by sediments.

Hence, during next phase of research we will focus on MFC processing by utilizing continuous flow of waste material/ water through MFC unit.

Table 1- Proposed Microbial Fuel Cell Results

Number of Fuel Cell	Temperature (d.c.)	% Power output as compared to battery
1	25	45
2	25	48
4	25	65
8	25	80

As per the analysis as renewable energy is a free resource utilization for energy generation, 80% power output as compared to batteries can be acceptable for household electrification need. Based on the proposed research, the policy can be developed to manage household waste by producing energy for individual purpose.

IV. CONCLUSION

In this paper the existing research of microbial fuel cell (MFC) is discussed. The chemical process which happens during the energy generation is explained. The flow of pre-processing to post-processing is depicted where new MFC model working is shown step by step. The pilot research is tested for household waste, sewage water and city food waste material. In this paper we also presented the microbial fuel cell testing results. The membrane less and duel chamber microbial fuel cell are analyzed for the feasibility understanding for future enhancements. The pilot project is successful and as a future enhancement design of electrodes can be developed for large scale MFC chamber.

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