Household Waste Management and Electricity Production using Biotechnology

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***Abstract*:- Microbial Fuel Cell (MFC) is a bio-electrochemical system that drives an electric current by using bacteria. It converts chemical energy into electrical energy without combustion reactions. In our research soil, MFC was constructed and bio-electricity was harvested from four different types of soil samples: River soil, Paddy cultivated soil, Waste deposited soil, and Vegetable soil. Production of electricity is measured and also waste management is linked with this research.**

Keywords:- Microbial Fuel Cell (MFC); River soil; Paddy cultivated soil; Waste deposited soil; Vegetable soil; Household waste management.

I. INTRODUCTION

Increased economic growth and Social development are leading to a large gap between energy demands and the availability of fossil fuels, leading to the depletion of it. New energy sources are a major concern as the world is predicted to run out of its fossil fuels within the next fifty years. Microbial Fuel Cells (MFC) technology represents a new form of renewable energy as they generate an electric current from organic matter which would otherwise be considered as waste. The concept of MFC was introduced in 1970's. An MFC can be defined as a biochemically catalyzed system, in which fermentative micro-organisms generate electricity by oxidizing bio-degradable organic matter.

Nowadays energy plays an important role in our life. fossil fuels are depleted and the demand for alternative energy generation has an increasing trend. Renewable energy may be a suitable alternative for existing energy sources. Power generated from Microbial Fuel Cell (MFC) is considered renewable energy.

The basic principle of Microbial fuel cells is the fermentation of the provided substrate by an organism. An MFC consist of two electrodes of special types of bio-fuel cells. It is a device that converts chemical energy into electricity through the catalytic activity of microorganisms.

II. METHODOLOGY

A. *Sample Collection*

The sample is taken from the soils such as:

- The soil was taken from the River
- Paddy cultivated soil
- Waste deposited soil
- Vegetable cultivated soil

B. *Components of MFC*

1. Anode: Conductive, bio-compatible, and chemically stable with the substrate. Stainless steel mesh or graphic plates.
2. Cathode: Electron and Proton recombine at the cathode. Oxygen is reduced to water.
3. Soil
4. Water
5. Wire

III. CONSTRUCTION OF MFC

A microbial fuel cell was constructed using the basic principle. A plastic container was used as the cell in which led functions as an electrode, an anaerobic anode and an aerobic cathode. The container was filled with waste material like kitchen garbage with soil and the anode was placed deep inside the container. The cathode was placed above the waste material in a way that it is exposed to the air. Both the electrodes were connected to an electronic multimeter using copper wire. Collected soils for construction of MFC are:

1. Waste deposited soil
2. Vegetable cultivated soil
3. River soil
4. Paddy cultivated soil

IV. RESULTS AND DISCUSSIONS

A. *Soil Testing*

Different soils samples collected were tested and analysed in soil-water analysis laboratory in Eranad, Kerala.The test results have been depicted in Table 1. The soil type 1,2,3,4 are same as discussed under section III. Table 1 show in the minerals available in the tested soil, pH and electrical conductivity.

Table 1: Analysis of tested soil samples

Soil Type	Electrical conductivity (ds/m)	organic carbon %	(mg/l)										
			Calcium	Magnesium	Iron	Manganese	Zinc	Copper	Potassium	Boron	Sulphur	Phosphorous	pH
A	0.02	3.71	540	134	30.1	12.2	2.3	4	45.51	0.22	1.66	9.14	3.73
B	0.02	2.51	470	137	28.3	15.7	2	3.16	46.9	0.68	3.18	10.1	5.79
C	0.01	1.23	359	148	24	21.1	1.66	2.89	49.4	0.84	4.31	14.2	6.83
D	0	0.46	235	156	21.4	28	0.91	1.84	54.7	0.98	5.43	16.8	7.21

B. MFC Construction and Results of Voltage.

The observation results of the four different soils are shown in the Table 2.

Table 2: Voltage from four different soils.

Days	Voltage (mV)			
	A	B	C	D
1	12	8	10	5
2	25	11	19	11
3	38	24	23	19
4	47	36	32	24
5	61	49	45	29
6	59	59	51	36
7	89	74	62	46
8	95	71	69	51
9	112	96	78	59
10	138	123	94	67
11	174	156	112	79
12	258	213	124	119
13	278	226	135	131
14	286	238	149	141
15	299	251	161	154
16	326	269	179	163
17	334	289	191	178
18	346	295	218	189
19	354	299	231	195
20	361	311	246	203

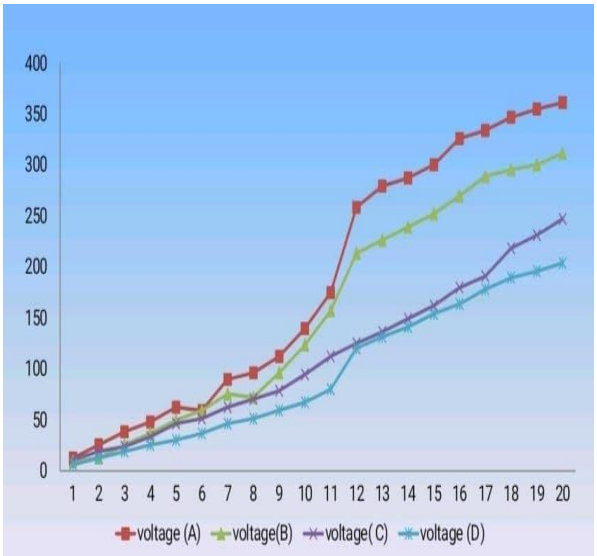

Fig. 1: Graph Showing Voltages of Four Different Soils

C. Electricity Production and Discussion.

Increasing human activities are consuming natural sources leading to the depletion of fossil fuels. Active researches are being carried out to find alternate sources of energy generation, especially from renewable sources. All the conventional energy production processes practiced today requires combustion of polluting fossil fuels, which is expensive and not environment-friendly. As an alternative way, bioelectricity generation through MFCs using a variety of substrates has been studied quite extensively. Bio-electricity is the electric power generated using MFCs called Microbial Reducing Power. The technology used for the production of bioelectricity is called MFCs. MFC is a bio-electrochemical transducer or a bioreactor or a biological catalyzed system that generates electricity by oxidizing biodegradable organic matter.

A Microbial fuel cell is an electrochemical device that converts chemical energy into electrical energy. A fuel cell is comparable to an electrolytic cell or battery, where chemicals are oxidized or reduced electrochemically to produce electricity. Among the fuel cells, microbial fuel cell and anaerobic anode and aerobic cathode. When the bacteria oxidize the substrate in a condition with fewer oxygen, electrons and protons are generated at the cathode. The electrons which were accepted by the anode and transferred through the external circuit combines with the proton and oxygen to form bioelectricity. Besides these components, another important part of MFC is the micro-organism used which is responsible for the oxidation of provided substrate resulting in the generation of electrons and protons. Micro-organisms can transfer electrons to the anode by direct transfer of electrons from the respiratory enzymes. The present study aims to design a single chamber MFC and to investigate its efficiency in proton exchange membranes and mediators are highly expensive and hence are not environmentally friendly. This study also evaluates different parameters which affect the production of electricity like biofilm temperature, agitation effect of electrodes, etc. Though the entire course of the study we intend to design a cost of effective and simple MFC.

V. Effect Of Different Parameters

After the soil testing, we get a soil profile of each soil and get the information that when the soil has more organic carbon, it gets more current and voltage. Waste deposited soil contains more organic carbon. After that to identify the bacteria, the electrode is given to the lab and we get the information of the bacteria,

a. Alpha-amylase bacteria
b. Cellulolytic bacteria
c. Lipolytic bacteria
d. Proteolytic bacteria

After the identification of colonies of the bacteria, put bacteria into the MFCs and also put the consortium of bacteria to another MFC and get more current in the consortium of bacteria containing MFC.

VI. Future Prospects

At the end of the study, as a prospect combining the result obtained from the present study and the working principle of a solar panel, if the design works then bio-electricity can be domesticated. The proposed apparatus including components like the charge controller to control battery charging. The power inverters that make 120V AC from the batteries to run your appliances the storage battery which stores the excess

power for use when the sun is weak or not available and AC generators for backup power.

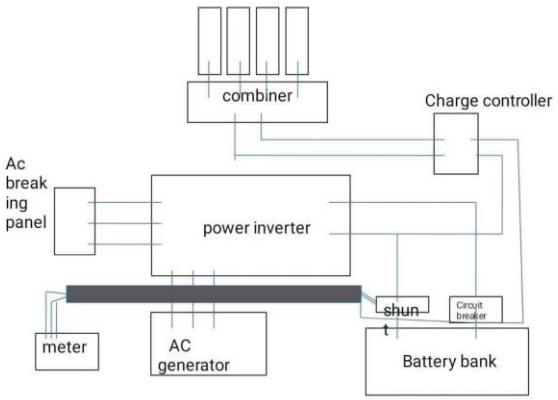

Fig. 2: Bio Electrical Panel

VII . CONCLUSION

This project is based on the implementation of new technology on how we can produce the most demanding factor in our day-to-day life in a scientific as well as in a systematic manner with high efficiency. This component that is our MFC uses low-cost products for its construction and working and the result is highly efficient and highly useful in our present situation. Alpha-amylase-producing bacteria, lipolytic bacteria, proteolytic bacteria, etc. are the main reasoning bacteria for the production of electricity.

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