Bactrosity

Abstract:

From the last few decades, we have seen many changes, some are favorable and some so aversive which are really becoming threat to the existence of life in our planet.

The most aversive change as we all know is climate change and it is in a faster pace in the geological chronometer. So, the prevention of the climate change is the utmost priority to save our planet. It has been understood already that one of the major causes of climate change or the global warming, is burning of fossil fuel which is also one of the major causes for Carbon footprint.
The sensible communities from all over the world have been started the journey to find the alternative sources of energy so that we can reduce the use of fossil fuel. Solar, Wind and Hydro are the most common alternative sources of energy, however among all the available alternative sources the most low-cost and manifold solution is **MFCs (Microbial Fuel Cell)**. The work on MFC started in 1911 however the work was not received much attention at that time. At the **late 1970**, the concept was studied by Robin M. Allen and later by H. Peter Bennetto. His work, started in **the early 1980s**, helped build an understanding of how biofuel cells operate. The most recent development done on MFC in **September 2023**, the researchers of Ecole Polytechnique Federale de Lausanne (EPFL) of Switzerland, have been successfully bioengineered the E. coli bacteria to increase the ability to generate energy. However, these all researches are for the large scale mainly for waste water management and waste management. There are many researches going on MFCs around the globe however the technique is not yet commercialized in a large scale and also for the domestic purposes.

Introduction:

In India 64% people lives in rural areas and here the agricultural sector holds the 21% of our GDP, we are concentrating our work on MFC mainly to solve some significant problems of agriculture as well as of rural inhabitants. Some work on MFC have been adapted but not received much attention. We believe the MFC could be the very good source of clean and affordable energy for the rural part of India as well as it will also helpful for waste management. So, our aim is to use the MFC for household purposes mainly in the rural part of India.

Innovation:

Most of the MFCs are robust in size and difficult to port from one place to another place as well as they are expensive due to the use of PEM (Proton Exchange Membrane)/ CEM, however most of these are still in research stage not yet commercialized. So, our aim is to use the MFC for household purposes mainly in the rural part of India and commercialization the portable MFCs for domestic uses.

We are doing our research on portable MFCs which could be easy to make and easily transported. Our MFCs can be made with normal mud from Paddy lands, Ponds, Cattle dung. There are three major parts of this project,

(i) Provide low-cost energy
(ii) Portability
(iii) Waste Management

Methodology:

The MFCs are of various types, viz, Mediated, Mediator free, Soil based, Phototrophic biofilm, Nanoporous membrane, Ceramic membrane. Apart from all of these, we are trying to make single chamber portable MFC.

Basically, we are making soil-based mediator less single chamber MFC. The Methodology is very simple. We have collected mud from ponds, cattle field and paddy lands. The three different places have been chosen to see the difference in outcome if any.

The following materials we have used:

1) Circular Disk (dia5.8 cm) Stainless Steel (SS) mesh for electrodes
2) Activated Carbon for the coating on electrodes
3) Flexible wire 1.75mm
4) Plastic container (cylindrical shape of capacity 200gm)

One Set:

1) **2 electrodes (Anode and Cathode)**
2) **190 gm of Mud**

First, we have made 8 circular disks of diameter 5.8 cm from the SS mesh, we have made fine powder of charcoal then paste the charcoal on the SS mesh disks to prepare our electrode.

In the next step we have put one disk at bottom as a cathode and fill with the mud of 190gm as per our container's capacity then placed the anode (another disk) at the top.

We have made four MFCs with mud from open field which is adjacent to the Buffalo cattle house and the second set of four MFCs with mud from paddy field.

SET UP of 2 Units (Each Unit 4 MFCs).

Testing with Red LED

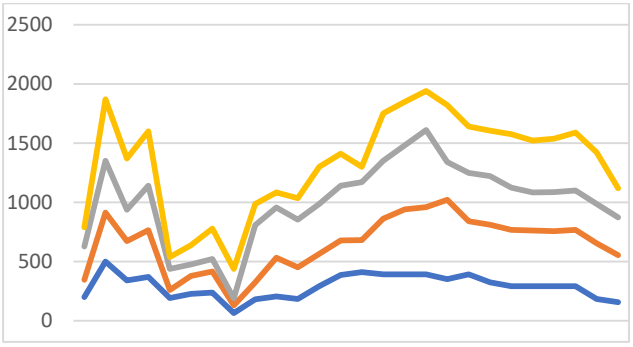
Testing with Blue LED

Testing with White LED

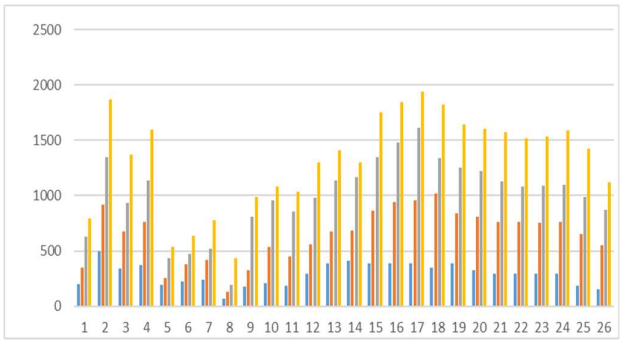
Observations:

Form the following log of one month, we can see the voltage at various conditions.
First set made on 07/09/2023 and second set made on 22/09/2023.

First Set:

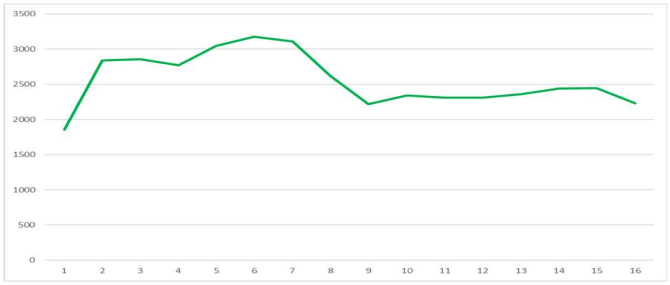


mV- Day



mV-Day

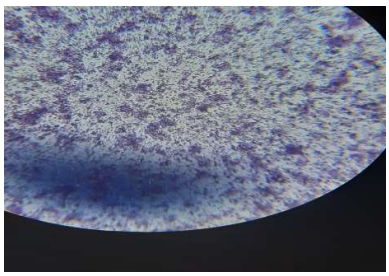
Combination (Set of 2)

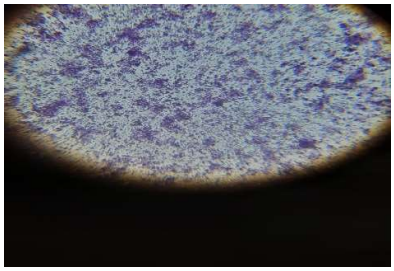


mV-Day (26 days)

From the log and chart, we have observed that the one set (4 Nos. MFC connected in series) could provide 1V steady voltage and combination of two set could provide 2V steady voltage so to glow one LED lamp **three set** of MFC will be appropriate or we can increase one set for the extra glow for one month. After one month, replacement of mud is required.

Gram Staining Result:





The gram staining result shows that we have positive gram bacteria in our mud however we are unable to find the exact bacteria colonies as we don't have the apparatus for bacteria culture in our school lab to culture the bacteria, but from the above result we can say the probable bacteria are Firmicutes, Bacillus subtilis, Bacillus cereus may present in the mud samples. As they are mostly anerobic in nature so it could be concluded the anerobic reactions are the cause of electricity generation in our MFC.

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

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

Overall reaction: $\frac{1}{2} C_6 H_{12}O_6 + H_2O + 3O_2 \rightarrow 4CO_2 + 4H_2O$

Data Logs:

First Set Data log: 07/09/2023 to 13/10/2023 (Cattle Filed Mud):

Date	Output	Single Cell	Double Cell	Tri Cell	Quad Cell	Remarks
	Voltage(mV)	200	345	627	789	Closed Lid
07-09-2023						
	Voltage(mV)	498	914	1350	1870	Closed Lid
09-09-2023		5	8	12	20	
	Voltage(mV)	340	672	937	1370	Openned Lid, all were connected in Series
11-09-2023						
	Voltage(mV)	370	764	1140	1600	Openned Lid, all were connected in Series
12-09-2023		46	10	14	20	
	Voltage(mV)	191	258	435	537	
13-09-2023						Openned Lid, all were connected in Series
	Voltage(mV)	225	378	475	636	
14-09-2023						After adding glucose of 1.5gm / cell
	Voltage(mV)	237	415	520	778	
15-09-2023						Openned Lid, all were connected in Series
	Voltage(mV)	65	128	189	437	
18-09-2023						Openned Lid, all were connected in Series
	Voltage(mV)	178	325	807	985	
20-09-2023						Closed Lid and Water added about 10ml each
	Voltage(mV)	205	532	956	1084	
21-09-2023						Closed Lid and exposed to light
	Voltage(mV)	182	452	852	1035	
22-09-2023						Closed Lid and exposed to light
23-09-2023	Voltage(mV)	292	562	984	1300	Closed Lid and exposed to light
25-09-2023	Voltage(mV)	384	676	1140	1410	Closed Lid and exposed to light
26-09-2023	Voltage(mV)	410	680	1170	1300	Closed Lid and exposed to light
27-09-2023	Voltage(mV)	390	860	1350	1750	Closed Lid, exposed to light and added water
28-09-2023	Voltage(mV)	390	940	1480	1850	Closed Lid and exposed to light
29-09-2023	Voltage(mV)	390	960	1610	1940	Closed Lid and exposed to light
03-10-2023	Voltage(mV)	350	1020	1340	1820	Closed Lid and exposed to light
05-10-2023	Voltage(mV)	390	840	1250	1640	Closed Lid and exposed to light
06-10-2023	Voltage(mV)	325	810	1220	1605	Closed Lid and exposed to light
07-10-2023	Voltage(mV)	292	765	1125	1575	Closed Lid and exposed to light
09-10-2023	Voltage(mV)	290	760	1084	1520	Closed Lid and exposed to light
10-10-2023	Voltage(mV)	290	756	1087	1535	Closed Lid and exposed to light
11-10-2023	Voltage(mV)	290	765	1100	1589	Closed Lid and exposed to light
12-10-2023	Voltage(mV)	184	655	985	1423	Closed Lid and exposed to light
13-10-2023	Voltage(mV)	156	554	872	1120	Closed Lid and exposed to light

Second Set Data Log 22/09/2023 to 13/10/2023 (Paddy field Mud):

Date		Single Cell	Double Cell	Tri Cell	Quad Cell	Remarks
	Voltage(mV)	141	398	644	824	Closed Lid and exposed to light
22-09-2023						
	Voltage(mV)	357	758	1191	1486	Closed Lid and exposed to light
23-09-2023						
	Voltage(mV)	350	734	1210	1460	Closed Lid and exposed to light
25-09-2023						
	Voltage(mV)	320	690	1170	1460	Closed Lid and exposed to light
26-09-2023						
	Voltage(mV)	270	650	1030	1240	Closed Lid and exposed to light
27-09-2023						
	Voltage(mV)	270	630	1010	1210	Closed Lid and exposed to light
28-09-2023						
	Voltage(mV)	230	590	950	1120	Closed Lid and exposed to light
29-09-2023						
	Voltage(mV)	190	500	770	900	Closed Lid and exposed to light and glucose of 1.5gm / cell
03-10-2023						
	Voltage(mV)	190	430	570	600	Closed Lid and exposed to light
05-10-2023						
	Voltage(mV)	190	450	620	750	Closed Lid and exposed to light
06-10-2023						
	Voltage(mV)	175	365	584	736	Closed Lid and exposed to light
07-10-2023						
	Voltage(mV)	175	410	609	789	Closed Lid and exposed to light
09-10-2023						
	Voltage(mV)	162	440	665	840	Closed Lid and exposed to light
10-10-2023						
	Voltage(mV)	165	438	678	889	Closed Lid and exposed to light
11-10-2023						
	Voltage(mV)	179	487	787	945	Closed Lid and exposed to light
12-10-2023						
	Voltage(mV)	185	554	854	1110	Closed Lid and exposed to light
13-10-2023						

Conclusion:
Portable MFCs could be a very good clean energy sources for a rural household. However, we have lot of work to do, this is only the initial part of our research, lot of works are still pending.

First: we have to design a comfortable carrying case which can hold 3 sets of MFCs which we have to make, so that we can get a steady 3V voltage to glow a white LED lamp also we have to design the case such as the replacement of mud will be easier and safer.

Second: we need to test the effects of substrates by using different type of substrate into the MFCs to observe whether it increase the current and voltage of MFCs.

Third: We need to design a charger circuit which could be used to charge a 3V battery so that we can also store the energy for future use.

Although, the MFCs could be a dual solution for waste management and the energy generation both. It could be a major energy resource in coming future.

References:

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