# Feasibility Studies on Electricity Generation from Dairy Wastewater using Microbial Fuel Cell

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**Abstract -** *For off grid generation of energy and treatment of substrate Microbial Fuel Cell (MFC) finds itself as a promising Technology. The experimental work conducted shows that MFC as an alternative technology to treat dairy wastewater. The main object of the existing paper "Feasibility Studies on Electricity Generation from Dairy Wastewater using Microbial Fuel Cell" is to evaluate the efficiency of dual chambered MFC which has got continuous feed of substrate. Dairy effluent was employed as substrate to MFC. Copper electrode having surface area of 123.4 sqcms was employed. Proton Exchange Membrane (PEM) made up of Agar NaCl Salt Bridge was utilized. The detention time of six hours is found to be optimum for maximum output. For optimized experimental set up the maximum efficiencies obtained in removal of COD, BOD, EC, TDS and Oil and Grease were 71.74%, 67.60%, 49.73%, 43.78% and 68.87%. Maximum power and electrical energy generated were 55.118 µW and 0.0992124 W-sec respectively.*

*The conclusion of the experiment is MFC can treat efficiently the substrate introduced into it along with generation of off grid energy.*

***Key Words***: Microbial Fuel Cell, Copper electrode, Dairy wastewater, PEM, Energy generated.

## 1. INTRODUCTION

An energy crisis which has developed due to industrial growth and modern life style is leading to depletion of fossil fuels, global warming and hike in the fuel price. There is an increase in population day by day which increases the requirement of food, water and shelter.

The Energy-Water-Food Nexus is the biggest challenge in the world. To fulfill worlds energy demand a necessary has raised to find alternative sources of energy from nonconventional resources. Among them biomass is one such source. Huge amount biomass can be obtained from sewage and industrial wastewaters. A technology has to be adopted to treat wastewater along with generation of energy. BES (Bio Electrochemical System) is one such method which utilizes microbial action to degrade organic matter along with generation of energy. MFC is one among BES. Without any energy input MFC treats the wastewater along with off grid energy generation. It is found to be a promising technology. But the technology is still in its infancy stage and needs attention of researchers. It is necessary to find out the performance of MFC for different substrates, electrodes, PEM, working conditions and conspiracies. In this experiment dairy effluent is considered as substrate Agar NaCl Salt Bridge as PEM, Copper as Electrode and three different detention time.

## 2. MATERIALS AND METHODOLOGY

Two chambered MFC having continuous flow was designed using materials available locally. All the required materials were taken and kept in laboratory to carry out the further procedure.

### 2.1 Collection and Analysis of Wastewater

From Bathi Milk Dairy, Davangere District the substrate required was collected and the initial parameters were tested. After analysis the sample was stored in refrigerator to avoid degradation.

The results obtained after analyzing the sample for influent characteristics are tabulated in Table 1.

**Table -1:** Initial Characteristics of Dairy Effluent

| Serial No. | Parameters | Results |
|---|---|---|
| 1 | COD (milligram/litres) | 7380 |
| 2 | $BOD_3$ (milligram/litres) | 5430 |
| 3 | EC @ $25^0$ C (µs/cms) | 752 |
| 4 | pH | 5.9 |
| 5 | TDS (milligram/litres) | 402 |
| 6 | Oil and Grease (milligram/litres) | 39.45 |

### 2.2 Preparation of Inoculums

In anode chamber, 3 liters of water, 100ml of substrate was added. For seeding 5gms of cow dung was used. Later the unit was packed and kept undisturbed for 7 days for the development of anaerobic bacteria's. Formation of thin biofilm will be noticed. Now the substrate will be introduced by removing the excess seed.

### 2.3 Preparation of Agar NaCl Salt Bridge

Add 3gms of Agar into container having 50ml 1molar NaCl Solution and allow it to dissolve. Heat the container until uniform solution is formed. Take 2cm dia 10cm length pvc pipe and pour the solution into it. Now freeze the solution by placing in refrigerator. Figure 1 shows the prepared salt bridge.

**Fig-1:** Agar NaCl Bridge

### 2.4 Working and Sample Collection from MFC

To make substrate uniform in condition it is kept out of the fridge and brought to normal temperature, it is stirred continuously for 25 min in magnetic stirrer. For anaerobic bacteria maintenance of pH and temperature is necessary.

Aspirating glass bottles are used as head balancing tanks to feed the substrate in to MFC. To maintain uniform flow rate 26.5cm head is maintained in the second, detension time is maintained by flow rate which is monitored by pinch clips. Anode is maintained for anaerobic condition while cathode is filled with distilled water. 5cm distance is maintained between electrode and salt bridge. Electrodes are attached to the copper wire and the wire is externally connected to the digital multimeter. For every half an hour current and volt readings are noted and the effluent obtained will be placed in fridge for further analysis.

**Fig-2:** Picturesque View of Experimental set up of MFC

## 3. RESULTS AND DISCUSSIONS

**Table-2:** Final Effluent Characteristics

| Parameter | Concentration and Efficiency of effluent at distinct DT | | | | | |
|---|---|---|---|---|---|---|
| | $DT_1$=2hrs | | $DT_2$=4hrs | | $DT_3$=6hrs | |
| | $C_{eff}$ | η% | $C_{eff}$ | η% | $C_{eff}$ | η% |
| COD | 3425 | 53.60 | 2459 | 66.66 | 2085 | 71.74 |
| BOD | 2649 | 51.21 | 1945 | 64.18 | 1759 | 67.60 |
| EC | 438 | 41.75 | 332 | 55.85 | 378 | 49.73 |
| TDS | 259 | 35.57 | 206 | 48.75 | 226 | 43.78 |
| Oil and Grease | 18.94 | 51.98 | 14.36 | 63.6 | 12.28 | 68.87 |
| pH | 6.83 | | 7.2 | | 7.48 | |

As the detention time increases there is increase in removal efficiency. Maximum removal efficiency is found for 6hrs Detention time. 71.74%, 67.60%, 49.73%, 43.78% and 68.87% are the removal efficiencies obtained for COD, BOD, EC, TDS and Oil and Grease respectively.

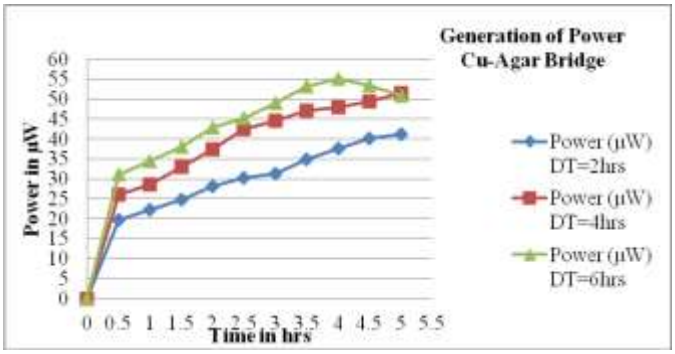


**Figure-3:** Generation of Power

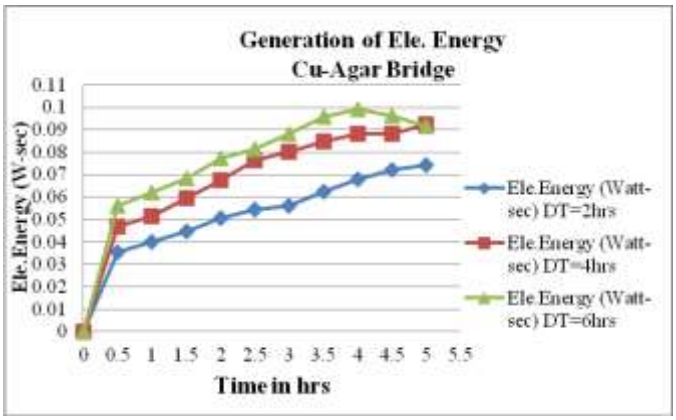


**Figure-4:** Generation of Electrical Energy

Figure-3 and Figure-4 is a graphical representation of electrical power and electrical energy generated for varying three detention time. Highest power and energy generated was 55.118 μW and 0.0992124 W-sec for detention time of 6hrs. There is gradual decrease in electrical energy and power after reaching its peak.

## 4. CONCLUSIONS

Following are the conclusions obtained from the experiment conducted,

- Microbial fuel cell proves itself to be successful in treatment and generation of power.
- Antimicrobial nature and corrosion are the drawbacks of Copper even though it's a very good conductor.
- Both in cost wise and efficiency wise Agar Bridge is best choice when compared with other bridges.
- Six hours detention is suitable for treatment as it has got high efficiency of removal as compared to two and four hours by employing Copper electrode.
- For optimized experimental set up the maximum efficiencies obtained in removal of COD, BOD, EC, TDS and Oil and Grease were 71.74%, 67.60%, 49.73%, 43.78% and 68.87%.
- From the above results it is concluded that MFC can treat dairy wastewater along with generation of energy.
- Corrosion problem can be overcome by employing corrosion resistant metal as electrode or by providing corrosion resistant coating to Copper.

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