EXPERIMENTAL INVESTIGATION ON RECENT ADVANCES IN MECHANISTIC CHARACTERISTICS OF MICROBIAL FUEL CELLS FOR OPTIMISING BIO ENERGY AND ITS GREEN STRATEGIES

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Keywords:

Single Chamber Microbial, Bioenergy, Wastewater Treatment

Introduction:

Water pollution, disposal of wastes and their management is the most important environmental problem faced by the world today. Agricultural waste, household waste and industrial waste are best substrates for energy production as they are rich in organic contents [1]. India is one of the leading producers of sugar in the world and has nearly 650 sugar mills that produce about 13 million tons of molasses and 15 million tons of sugar. These sugar mills discharge a bulk amount of wastewater per day without proper treatment during working seasons, for every one tone of sugarcane crushed the sugar industries generates about thousand liters of wastewater from different units, sugar industry wastewater has high COD and BOD, which is hazardous for aquatic life and human use [2]. MFC have gained importance in the last few decades due to their ability to produce bioelectricity from renewable sources, MFCs have been used to treat various kinds of wastewater such as Sugar, brewery, domestic sewage, distillery, rice mill, paper and pulp, swine wastewater etc. Sugar mill wastewater is an important source of organic material thus microorganisms degrade the organic matter there by releasing electrons and protons. Electron flow leads to the generation of electricity in Microbial Fuel Cell. In this study, generation of electricity from sugar mill wastewater is carried out using single chambered MFCs.

Microbial Fuel Cell [MFC]

"MFCs are Bio-reactors that can utilize microorganisms for converting chemical energy into electrical energy under anaerobic condition".

Basic MFC design consists of two compartments one is anode and the other is cathode. These two compartments are separated by proton exchange membrane. Substrate is oxidized in anode chamber by using microorganisms, producing electrons, protons and carbon dioxide (CO_2). The electrons are transferred from anode compartment to cathode compartment through an external circuit and protons are transferred from anode to cathode compartment through PEM (as salt bridge). In cathode compartment, protons, electrons are consumed and combining with oxygen (O_2) to form water, simplified cross view of MFC as show in Figure 1.2 [4]

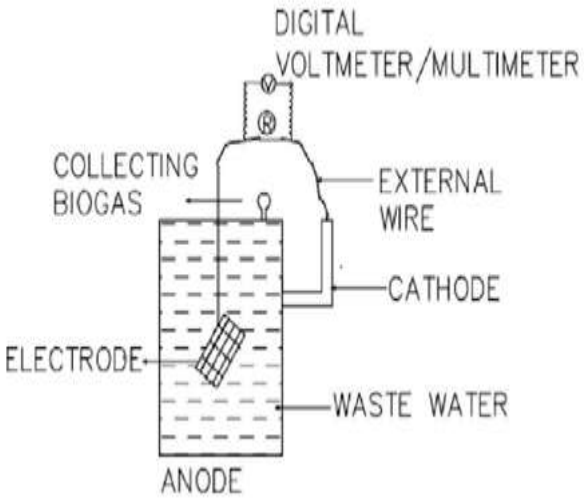


Figure 1: Working Mechanism

Objectives:

1.To identify and collect suitable domestic wastewater from hubli-dharawad by observing its initial characteristics

2.To design and fabricate single chambered microbial fuel cell.

3.To optimise Biogas (Methane Gas) generation and maximum power output.

4.To find out BOD and COD removal efficienc

Methodology:

1. The project Collection of domestic wastewater from 40MLD SBR based Sewage Treatment Plant, Gabbur village,Hubballi.
2. Design and Fabrication of single chambered microbial fuel cell
3. Domestic wastewater and 0.33% of cow dung (inoculums) will be filled in single chambered microbial fuel cell.
4. After some days it will start generating the electricity, during this study period wastewater has been treated up to some extent since the process is in anaerobic condition. During the study period generation of electricity has been monitored using Bristow LCD display digital Multimeter.
5. Anaerobic digestion process has been taken place due to the influence of microbes (Geobacter sulfurducences) are able to generate biogas; it will be collected in biogas collection pouch.
6. During the study period important controlling parameters like pH, turbidity, solids, acidity, alkalinity,hardness, Do, COD and BOD will be analyzed.

Result and Conclusion:

4.1 Power, Voltage and Current Generation and COD removal Efficiency in

Sl no	Time in Days	Power in (mW)	Voltage in (mV)	Current (mA)
1	1	1508	325	4.64
2	2	1562.32	331	4.72
3	3	1573.68	332	4.74
4	4	1207.65	291	4.15
5	5	1200.6	290	4.14
6	6	1120	280	4
7	7	1039.5	270	3.85
8	8	1055.36	272	3.88
9	9	882.5	250	3.57

Table 1: Power, Voltage and Current Generation in MFC-I

MFC-I

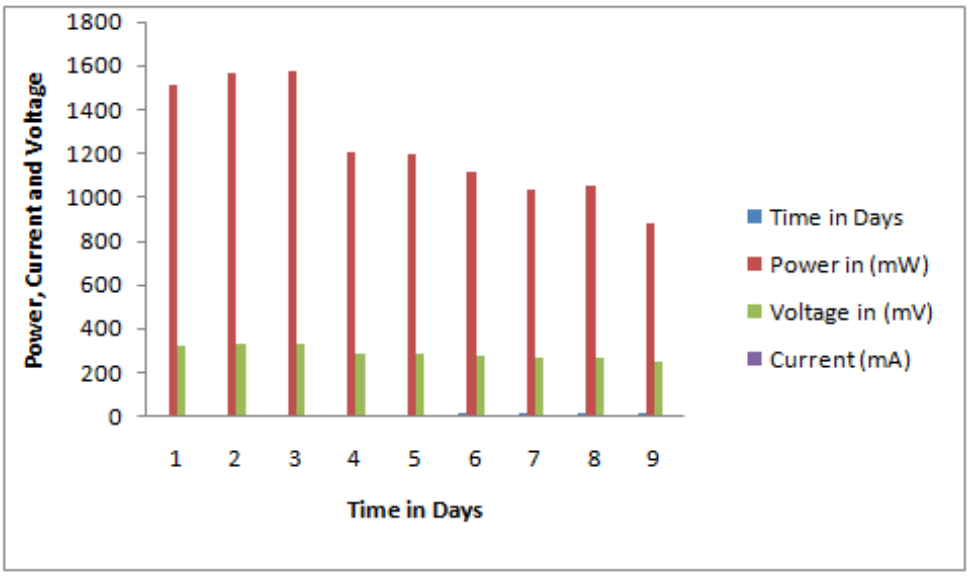
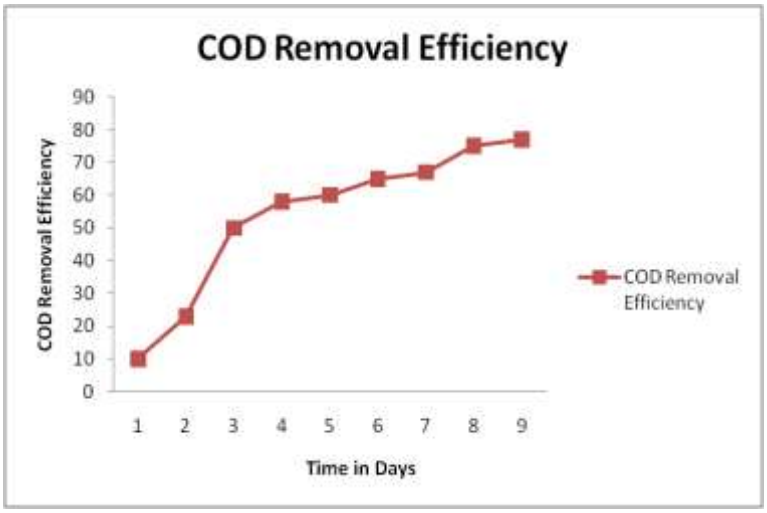


Figure 2 : Power, Voltage and Current Generation in MFC-I



Maximum COD Removal Efficiency in MFC-I is 77%

Power, Voltage and Current Generation and COD removal Efficiency in MFC-II

Sl no	Time in Days	Power in (mW)	Voltage in (mV)	Current (mA)
1	1	11.2	28	0.4
2	2	22.8	40	0.5
3	3	42.9	55	0.78
4	4	762.3	231	3.78
5	5	1001.7	265	3.3

6	**6**	**1026.05**	**268**	**3.82**
7	7	716.8	224	3.2
8	8	696.15	221	3.15
9	9	696.15	221	3.15
10	10	588.7	203	2.9

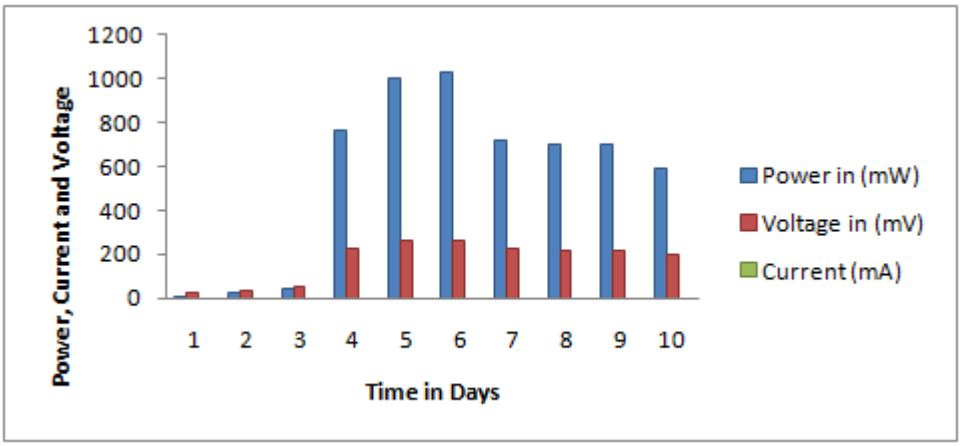
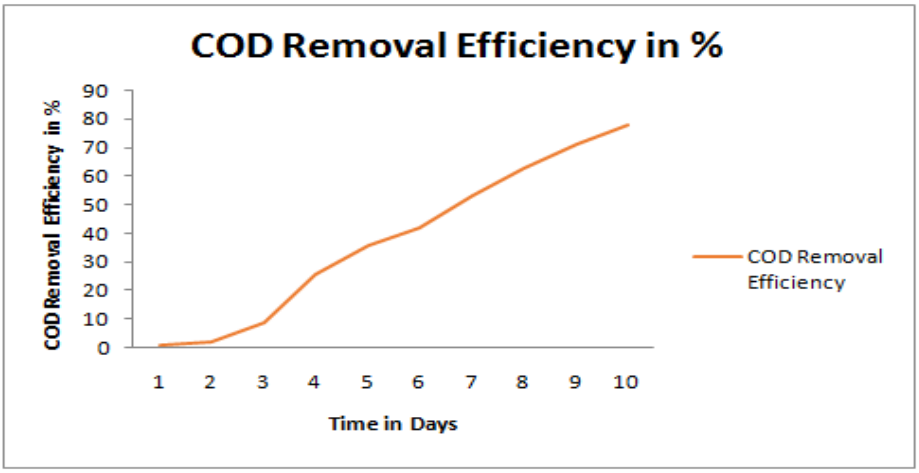


Figure 3: Power, Voltage and Current Generation in MFC-II



Maximum COD Removal Efficiency in MFC-II is 78%

Expected Outcome of the project:

1. Bioenergy (Electricity and Biogas)

2. Treatment of wastewater

Working Model of the Project

Scope for Future Work

1. Improving efficiency, reducing costs, and expanding applications, including wastewater treatment, renewable energy, and bioremediation, while addressing challenges like scalability and long-term stability.
2. Improving Electrode Materials:
3. Optimizing Microorganism Selection:
4. Advanced Membrane Technologies:
5. MFC Can be used in Sewage Treatment Plant/Effluent Treatment Plant
6. Energy can be stored by means of Batteries

Conclusions

Based on the laboratory study conducted

The conclusions are as follows.

1. Maximum Power, Voltage and Current generation in MFC-I is observed as 1573.68(mW), 332mV, 4.74 (mA) at 3 rd day
2. Maximum Power, Voltage and Current generation in MFC-II is observed as 1026.05(mW), 268 mV, 3.82 (mA) at 6 th day
3. Maximum COD removal Efficiency in MFC-I is 77% and in MFC-II is 78%
4. MFC-I demonstrated a greater removal efficiency in COD and the ability to generate the maximum power output in a shorter amount of time when compared to MFC-II.