Microbial Fuel Cell: An Approach for the Utilization of Sugar Mill Waste Water for the Generation of Electricity

Prateek Jyotishi[1] Prof. Dal Chand Rahi[2]
[1]M.E. Scholar [2]Assistant Professor
[1,2]Department of Civil Engineering
[1,2]Jabalpur Engineering College Jabalpur, Jabalpur (M.P.), India

Abstract— Microbial Fuel Cell (MFC) is feasible to use as an alternative to conventional wastewater treatment techniques. This paper work successfully represents the MFC as a significant technology in the sugar manufacturing industry, uniting wastewater treatment and electricity production. The optimized design parameters are found out by evaluating the practicability of using different electrodes, varying detention time and increased electrode surface area. MFC in which stainless steel, Graphite is incorporated as electrode and Agar-NaCl salt bridge is used as proton exchange membrane is finally identified as the optimum design at 10 days detention time with an electrical energy generation of 319mV to 1067mV respectively. The percentage of removal efficiencies achieved in the optimized experimental setup for various parameters such as COD, BOD, and TDS correspondingly. Finally it has to be concluded that "Microbial Fuel Cell Technology" is efficient for sugar mill wastewater treatment and simultaneous energy recovery.

Keywords: Microbial Fuel Cell (MFC), Sugar mill wastewater, Bio- electrochemical systems (BES)

I. INTRODUCTION

Some of the biggest challenges the world is facing in the last 2 decades are energy crisis due to continuous depletion of fossil fuels, increasing price of fuels and global warming. Increasing pollution levels in terms of CO_2 emissions are not on track which causes global warming. As the world's population increases day by day, the demands such as water, food and energy sources are also increases. The Energy-Water-Food Nexus is the biggest challenge in the world. If it is possible to find a better solution to resolve one challenge could improve the others. To quench the world's energy demand, it is important to find alternative energy source which comes under renewable energy sources. As the availability of fossil fuels decreases, the market price gets increased. Numbers of researches are carrying out day by day related to renewable energy in order to find suitable technology which does not harm environment. Along with popular renewable energy such as solar and wind, biomass, bio-fuel etc. have also gain attention in the recent decades. But more technological innovations are required to eliminate the limitations of all available renewable sources of energy.
Industrialization results not only high production, but also increased water usage as well as waste generation. Energy recovery from waste is one of the interesting topics for research. Energy can be recovered in different forms such as electrical energy, heat or natural gas. Comparing with other forms of waste, wet waste (wastewater) is the one from which energy recovery can be done efficiently. Bio-electrochemical systems (BES) are those which generate electricity from biomass by spontaneous bacterial activity. Microbial fuel cells (MFC) are one of the major types of BES. Microbial fuel cell is a promising technology by which simultaneous wastewater treatment and energy generation can be accomplished without any energy input. Potential of microbial fuel cell to treat wastewater and to generate energy in pilot scale is yet to be evaluated.

It is important to evaluate the feasibility of using different substrates and different electrode materials for which the study can be extended to a pilot scale, and in the present study an attempt has been made to evaluate the effects of MFC with sugar mill wastewater for different variables such as different electrode configurations, varying surface area and detention time. Efficiency of microbial fuel cell in treating dairy wastewater is analyzed for all variable designs and effort is put to find out the optimum design. Along with treatment efficiencies, electrical properties of MFC is also studied in terms of power generation and electrical energy produced.

II. MFC COMPONENTS

Microbial Fuel Cell majorly constitutes Electrodes, Anodicand Cathodic Chamber and Salt Bridge. The Anodic chamber is ananaerobic chamber, which holds the substrate and the biocatalyst-Microorganisms. The cathodic chamber was maintained in aerobiccondition. The salt bridge that forms a bridge between cathodic andanodic chamber facilitates the transfer of ions (protons). Steel and Graphite electrodes were used as anode and cathode.

III. MFC SET-UP CONSTRUCTION

A two chambered fuel cell was constructed. Two plastic containers each with diameter 20 mm were taken and marked cathode and anode. Two holes of diameter 6 mm and 1.5 mm were made on each of the lids for the insertion of the salt bridge and electrodes. In the anode container, distilled water is used 1000m and in the cathode container 1000 ml of Dairy waste water with activated yeast was used and the anodic container lids were closed air tight and sealed with tape.

IV. SALT BRIDGE PREPARATION

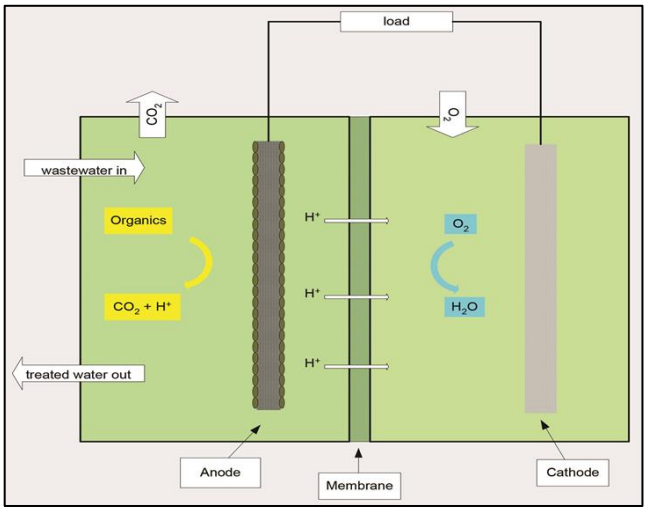
Salt bridge was made with 5mm diameter level tube. The salt bridgewas prepared using NACL with 5% Agar was boiled for 5-10 minutes. The mixture was sucked into the level tube and allowed to solidify. This individual salt bridge was inserted into the corresponding
MFC and sealed with tape.

V. COLLECTION OF WASTEWATER AND ANALYSIS

Sugar mill wastewater is used as substrate in MFC and it is collected from sk sugar mill kudwan mandla District. Collected wastewater is stored in the refrigerator at 4ºC in order to retard the microbial activity. This wastewater is non toxic and rich in organic matter and it is analyzed in the laboratory to find out the initial characteristics of the wastewater such as COD, BOD, pH, TDS and the test results are shown in Table-1 below.

Sl No.	Parameters	Results
1.	Colour	Greyish black
2.	Odour	Bad
3.	pH	6.1
4.	BOD (mg/L)	623
5.	COD (mg/L)	1786
6.	TDS (mg/L)	1891

Table 1: Initial Characteristics of Dairy Wastewater



VI. EXPERIMENTAL SETUP

The general arrangement of microbic cell for electricity generation includes the subsequent items:

- Two plastic bottles of a thousand metric {capacity unit} capacity.
- Salt bridge to interconnect the bottles.
- Two electrodes.
- Two electrical leads from plumbago electrodes for voltage measuring.
- Multimeter and yeast as an accelator.

VII. RESULT AND DISCUSSIONS

Removal efficiencies along with the electrical properties are monitored for each experimental setup and experimental setup with stainless steel of larger surface area showed higher removal efficiency and stable electrical properties. The extent of COD removal is noted as 83.58%, whereas BOD removal efficiency is 91.65% as comparing with all other results. Graphical representation of in electricity generation with respect to various experimental setups are shown below. Variation

A. Characteristics of Dairy Wastewater

Sl No.	Parameters	Before	After
1.	Colour	Greyish black	Greyish black
2.	Odour	Bad	Bad
3.	pH	6.1	6.4
4.	BOD (mg/L)	623	571
5.	COD (mg/L)	1786	1493
6.	TDS (mg/L)	1891	1817

B. Efficiency of electricity generation

Number OF Days	Steel electrode (mV)	Graphide (mV)
1	636	357
2	659	423
3	808	567
4	913	681
5	978	871
6	1067	814
7	879	719
8	524	627
9	389	424

10	146	269

VIII. CONCLUSIONS

- From the experimentation named "Microbial Fuel Cell :- An Application For sugar mill Wastewater Treatment and Electricity Generation the following conclusions have been made:
- The present study successfully presents the MFC as an excellent resource recovery technology in the sugar mill industry; unite wastewater treatment and off- grid electricity production. The good outcomes and consequences of using two different types of electrodes (Stainless Steel and Copper) as anodic and cathodic electrodes in MFC are monitored and Stainless Steel is found significantly better in terms of both treatment efficiency and electricity generation.

