



Exploiting A Microbial Fuel Cell To Produce Power From Wastewater In The Food Processing Company

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Abstract: Wastewater from the food processing industry is characterized by high levels of chemical oxygen demand (COD) and biological oxygen demand (BOD), contributing to significant pollution. The composition of this wastewater varies greatly due to the diverse range of fruits, vegetables, and raw materials used, as well as the different products manufactured. The production of various items often involves the addition of preservatives, colors, salts, oils, sugars, gelatin, and other ingredients, which further increases the pollutant load. Recently, the use of single-chamber MFC for electricity generation has gained attention. This study explores the potential of MFCs to generate power from food industry wastewater. A microbial fuel cell system was employed to achieve this objective, and voltage production was measured using a multimeter. For the single-chamber MFC, wastewater from the food sector demonstrated a COD removal of 69% and BOD removal of 62.38%, with feed concentrations of 3000 mg/L. The system generated a current of 0.45 mA and a voltage of 89 mV. In comparison, the dual-chamber MFC achieved a COD removal of 65.37% and BOD removal of 60.81%, with the same feed concentration, producing a current of 0.4 mA and a voltage of 86 mV.

Index Terms - Microbial fuel cell, Brewery wastewater, COD efficiency, BOD efficiency.

I. INTRODUCTION

Metropolitan cities are becoming central to the modern era, facing energy and environmental challenges brought about by industrialization. Industries in these cities produce wastewater with varying characteristics and concentrations. The volume of water used, the types of fruits and vegetables processed, and the different additives such as salt, sugar, gelatin, color, oil, and preservatives all contribute to the pollution load in the wastewater. Although these wastewaters contain fewer harmful chemicals, they can still be toxic. In the brewery industry, for example, water plays a crucial role not only as an ingredient but also as a primary cleaning agent.

Globally, the demand for energy is increasing every year. Fossil fuels provide around 86% of the energy produced worldwide. Fossil fuels, petroleum in particular, we are running out of coal which means we will soon face energy crises. Moreover, burning fossil fuels releases extra CO₂ into the atmosphere, which contributes to global warming. Therefore, the creation of a unique energy source is necessary to take the place of fossil fuels.

In an attempt to meet this energy need, humanity has been looking into alternate energy sources & attempting to harness all available energy source, including wave & ocean current, solar nuclear, water, wind, & geothermal energy. Fuel cell technology offers a targeted approach to decreasing the quantity of fossil fuels required in the production of power.

i. OBJECTIVE OF STUDY

1. To analyze the properties of wastewater from brewery production for industrial applications.
2. To assess the effectiveness of treatment based on COD and BOD levels.
3. To investigate the current and voltage generation rates of single- and dual-chamber microbial fuel cells.

II. LITERATURE REVIEW

Abhilasha Singh Mathuriya and V.N. Sharma (2009) Since it recovers energy from renewable materials that can be challenging to dispose of, such organic wastes and wastewaters, microbial fuel cell technology is a novel kind of sustainable and renewable technology for the production of electricity. The current contribution showcases the generation of power from wastewater originating from beer breweries, sugar industries, dairy farms, municipalities, and paper industries. In ten days of operation, a maximum current of 14.92 mA and a 90.23% elimination of COD were attained.

Nazario-Naveda, R., Rojas-Flores S, et al. This research proposes an alternative for companies and farmers through the production of electricity using microbial fuel cells (MFCs) using waste from export products. Nine MFCs were manufactured with zinc and copper electrodes; and as substrates, pineapple, potato and tomato pulp wastes were used in the anode chamber, and residual sludge in the cathode chamber. It was observed that the MFCs with pineapple substrate generated higher values of the electrical parameters, resulting in voltage and current values of 0.3484 ± 0.003 V and 27.88 ± 0.23 mA, respectively. It was also observed that the maximum power density was 0.967 ± 0.059 W/cm² at a current density of 0.04777 A/cm² for the same substrate.

Soumya Pandit & etal (2021)

As a result, an effective agro-waste treatment system has several benefits, including energy recovery and waste stabilization. To reduce the impact of the consumption of fossil energy sources on our planet, the exploitation of renewable sources has been re launched. Several technologies and recovery methods have been developed in recent years. The microbial fuel cell (MFC) is one of them. This review describes the power generation using various types of agro-industrial wastewaters and agricultural residues utilizing MFC. It also highlights the techno-economics and lifecycle assessment of MFC, its commercialization, along with challenges.

III. MATERIAL & METHODOLOGY

- i. Manufacturing process: One Chamber (MFC-1) & Two Chamber (MFC-2), MFC had been fabricated for the treatment of food processing industry wastewater.

The purposes of the materials used to make MFC: The anode & cathode chambers are made of plastic in these boxes. The wastewater is stored in the anode chamber, which has a capacity of 10 liters & a working volume of 7.5 liters. A conductive salt solution is stored in the cathode chamber. Agar Agar salt is used to make the membrane for ion transfer & agar salt bridge that keeps the liquids at the anode & cathode separate. Anode & cathode materials are made of carbon rods. Copper wire connects the electrodes to the millimeter, creating an external circuit. The agar salt mixture, also noted as the agar salt bridge, is held in proton exchange membrane. Sealant to stop leaks, epoxy was use to seal PVC pipe to the sides of the plastic boxes. The current & voltage are measured with a digital multimeter.

IV. RESULTS & DISCUSSIONS

- i. **Results:** The characteristics of brewery waste water & the experimental data relating to 1 chambered & 2 chambered MFC are discussed in this chapter.

SL.NO	CHARACTERISTICS	UNIT	BREWERY INDUSTRY WASTEWATER
1	pH	-	4
2	Turbidity	JTU	2000
3	Colours	-	Creamish Yellow
4	Total Solids	(mg/L)	25
5	Total dissolved solids	(mg/L)	4
6	Total Suspended Solids	(mg/L)	15.6
7	Total hardness	(mg/L)	720
8	Calcium hardness	(mg/L)	220
9	Magnesium hardness	(mg/L)	500
10	Chlorides	(mg/L)	459
11	Sulphate	(mg/L)	65
12	COD	(mg/L)	4000
13	BOD ₅ @20°C	(mg/L)	2815

Table 5.1 Characteristics of brewery wastewater

- ii. Brewery wastewater's COD removal efficacy & percentage reduction for different dose levels in MFC-1 & MFC-2

In both MFC-1 and MFC-2, continuous COD removal was observed. As shown in Figure 1, when the dosage increased from 1000 mg COD/L to 3000 mg COD/L, the COD removal efficiency in MFC-1 improved from

51% on day 1 to 69% on day 15. On the 15th day, MFC-1 achieved a COD reduction of 69%. In MFC-2, as the concentration rose from 1000 mg COD/L to 3000 mg COD/L over the same period, the COD removal efficiency reached 65.37%. By day 15, MFC-2 also reached its peak COD reduction performance of 65.37%. According to Figure 2, increasing the feed concentration from 3000 mg COD/L to 4000 mg COD/L led to a slight decrease in COD removal efficiency, with MFC-1 dropping from 69% to 68.13% and MFC-2 decreasing from 65.37% to 64.55% after the fifth day.

Because of higher organic loading in MFC-1 & MFC-2, the microorganisms entered a decline phase or phase of inactivity after a concentration of 3000 mg COD/L.

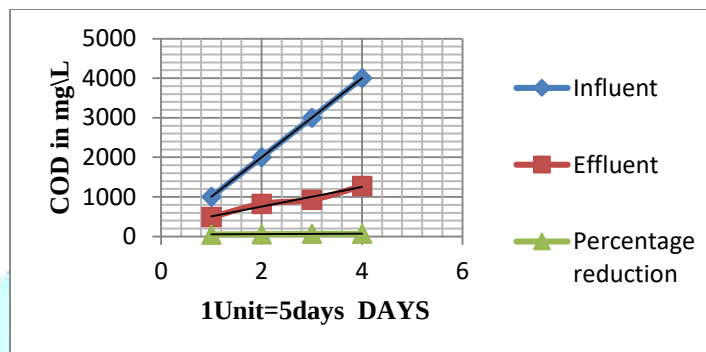


Figure 1: Performance of COD Removal in MFC-1

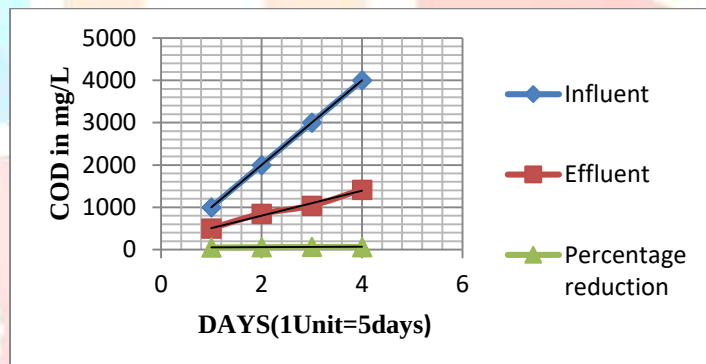


Figure 2: Performance of COD Removal in MFC-2

iii. Brewery wastewater's Performance of BOD & percentage reduction for certain dosage concentrations in MFC-1 & MFC-2

MFC-1 and MFC-2 demonstrate effective BOD removal from brewery wastewater. As shown in Figure 3, when the feed concentration increased from 700 mg/L to 2100 mg/L, the BOD removal efficiency in MFC-1 improved from 50.71% on day 1 to 62.38% on day 15, with the highest BOD removal of 62.38% achieved on the 15th day. Similarly, in MFC-2, as the concentration rose from 700 mg/L to 2100 mg/L, the BOD removal efficiency increased from 47.43% to 60.81% between day 1 and day 15, as shown in Figure 4. On day 15, MFC-2 reached its highest BOD removal efficiency of 60.81%. However, when the dosage increased from 2100 mg/L to 2800 mg/L after day 5, BOD removal efficiency slightly decreased, dropping from 62.38% to 61.43% in MFC-1 and from 60.81% to 58.93% in MFC-2. This decline occurred due to the higher organic loading, causing microorganisms in both MFC-1 and MFC-2 to enter a decline or inactivity phase after reaching a concentration of 2100 mg/L.

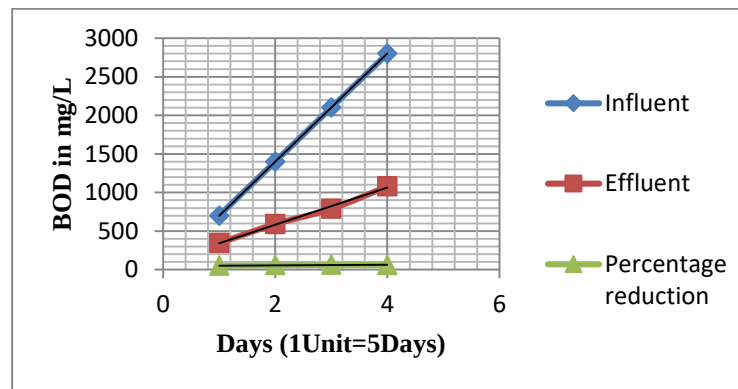


Figure 3: Efficiency of BOD Removal in MFC-1

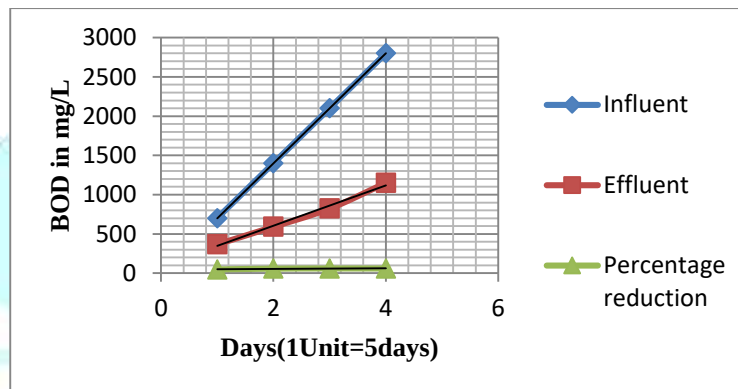


Figure 4: Efficiency of BOD Removal in MFC-2

V. CONCLUSIONS

On analysis the result drawing from the laboratory experiment conducted, the following conclusions are drawn

1. MFC-1 brewery wastewater with varying input concentrations demonstrated 69% COD & 62.38% BOD removal. The reactor's voltage & current are 0.45 mA & 89 mV, respectively.
2. MFC-2 brewery waste water with varying input concentrations demonstrated 65.37% COD & 60.81% BOD Removal. The reactor's current & voltage are, respectively, 0.4 mA & 86 mV.
3. Because the cathode in single chamber MFCs (MFC-1) is exposed to air & has sufficient of oxygen, which accepts the generating electrons, MFC-1 proves to be better to MFC-2 for current production.
4. When looking at construction costs, maintenance, & electricity generation, the single chambered MFC (MFC-1) is more economical than the double chambered MFC (MFC-2).

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