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Microbial fuel cell-based power generation from wastewater in the food processing industry

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Abstract: Food processing industry wastewater has a high biological oxygen demand (BOD) and chemical oxygen demand (COD), which leads to pollution problems. Furthermore, the qualities of wastewater show a great deal of heterogeneity because different fruits, vegetables, & raw materials are used; furthermore different product types are made. The creation of different products necessitates the addition of numerous preservatives, colors, salts, oils, sugars, gelatin, & other ingredients, which raises the pollution load. Recently, there has been an > in the use of microbial fuel cells (MFCs) with only one chamber for the production of power. This study investigates the use of MFC in the production of electricity from food sector wastewater An MFC system containing microbes has was used to fulfill the purpose of this investigation. It is possible to declare that the highest voltage that can be produced on the results of many different waste waters samples using a multi meter, the potential difference produced by the MFC was determined .For one chamber MFC, food wastewater, it showed 69% COD, 62.38% BOD, removal with feed concentrations of 3000 mg/L. Current generation & voltage are respectively 0.45 mA, 89mVolts. For dual chamber MFC, the food wastewater showed 65.37% COD, 60.81% BOD, removal with feed concentrations of 3000 mg L. Current generation &voltage are respectively 0.4mA, 86 mV respectively.

Index Terms **- MFC, Brewery waste, COD Removal, BOD Removal.**

I. INTRODUCTION

The Metro political city is becoming the focus of the modern period. The energy & environmental challenges & the results of the industrial revolution. These businesses produce wastewater, which varies in strength & properties. Variations in the amount of water used, the kinds of fruits & vegetables used, the products used, the combination of different additives such as salt, sugar, gelatin, color, oil &preservatives also contribute to the wastewater pollution load, but because these wastewater contain fewer hazardous compounds, they are toxic by nature, In the Brewery production section, water, It is the main ingredient, is frequently utilized as a 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 CO_2 into the atmosphere, which contribution 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.

II. OBJECTIVE OF STUDY

1. To study the characteristics of brewery manufacturing wastewater for industrial use.
2. To determine the impact of the treatment performance in terms of COD and BOD.
3. To examine at the rates at which 1 & 2 chambered microbial fuel cells generate Current & voltage.

III. 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, etal. 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.

IV. MATERIAL & METHODOLOGY

4.1 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.

V. RESULTS & DISCUSSIONS

5.1 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	NTU	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	$BOD_5@20^0C$	mg/L)	2815

Table 5.1 Characteristics of brewery wastewater

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

In MFC-1 & MFC-2, continuous COD elimination was seen. According to Figure 1, as the dosage level raised from 1000 mg COD/L to 3000 mg COD/L, the Performance of COD reduction in MFC-1 more from the first day to the fifteenth from 51% to 69%. On the 15th day, MFC-1's Performance of COD reduction is 69%. In MFC-2, the dosage concentration raised from 1000 mg COD/L to 3000 mg COD/L, respectively, from day 1 to day 15, resulting in a more in COD elimination performance of 65.37 percent. On day 15, MFC-2's Performance of COD reduction is at its high level, at 65.37 percent. According to Figure 2 the feed concentration decreased COD removal efficiency from 69% to 68.13% in MFC-1 & 65.37% to 64.55% in MFC-2 after the fifth day, from 3000 mg COD/L to 4000 mg COD/L.

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.

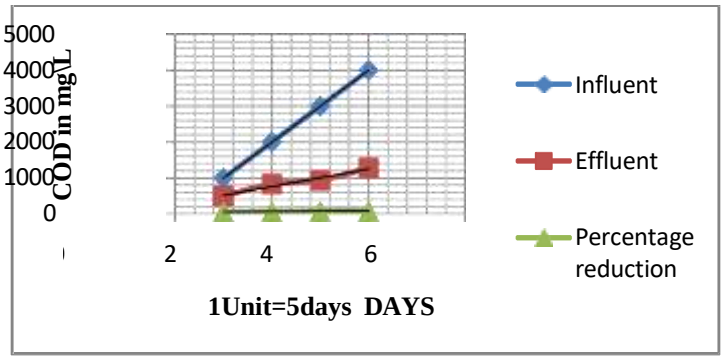

Figure 1: Performance of COD Removal in MFC-1

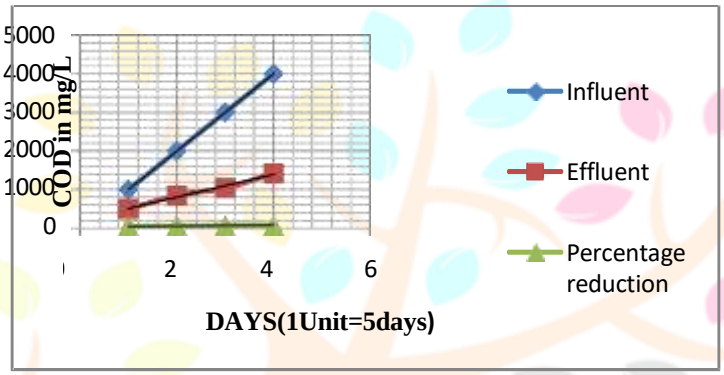

Figure 2: Performance of COD Removal in MFC-2

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

MFC-1 & MFC-2 show that brewery wastewater effectively removes BOD. According to Figure 3, as the feed concentration increased from 700 mg/L to 2100 mg/L, the BOD elimination effectiveness in MFC-1 is more from day one today fifteen 50.71 percent to 62.38 percent. On the 15th day, MFC-1 achieves the highest Effectiveness of elimination of BOD of 62.38%. The dosage level improved from 700mg/L to 2100 mg/L, respectively, In MFC-2, the BOD removal efficiency raised from day 1 to day 15 from 47.43 percent to 60.81 percent, as depicted in Figure

4. On the 15th day, MFC-2 has the more COD elimination efficiency of 60.81 percent. As dosage level improved from 2100 mg/L to 2800 mg/L after the fifth day, the BOD elimination efficiency reduced from 62.38% to 61.43% in MFC-1 & 60.81% to 58.93% in MFC-2.Because of higher organic loading in MFC-1 & MFC-2, the microorganisms entered a decline phase or phase of inactivity after 2100 mg/L concentration.

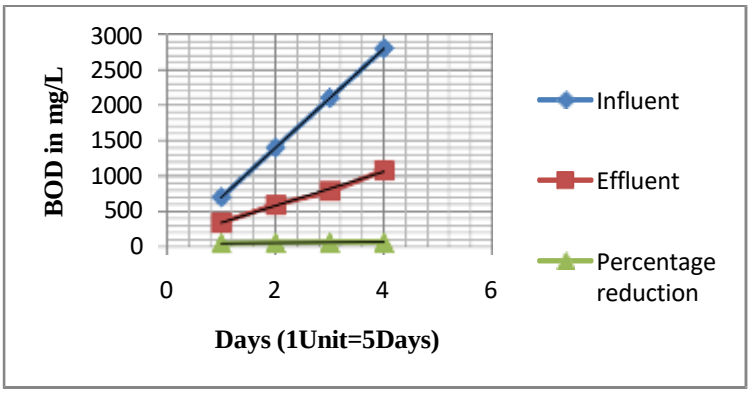

Figure 3: Efficiency of BOD Removal in MFC-1

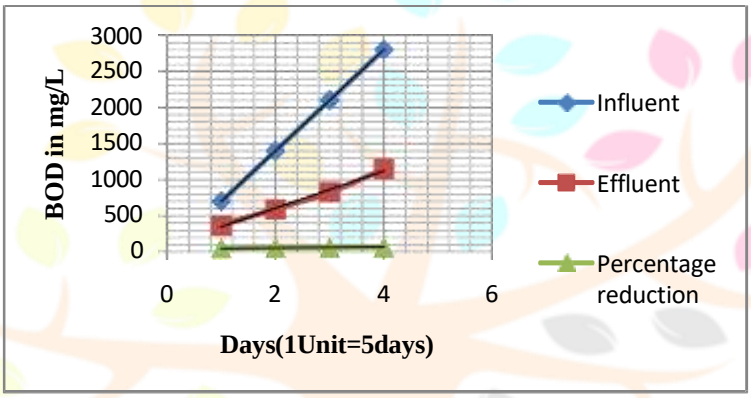

Figure 4: Efficiency of BOD Removal in MFC-2

VI. 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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