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Generation of Electricity Using Sugar mill Waste Water by Microbial Fuel Cell

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Abstracts

The application of microbial fuel cell (MFC) for electricity generation has been developing recently. This research explores the application of single chamber MFC in generating electricity using sugar wastewater.The different concentration of wastewater has been performed. The maximum current, voltage, BOD, COD ,pH and TDS obtained with respect to time. MFC of sugar mill wastewater showed removal efficiency 69.3% COD, 68.1% BOD and 56.35% TDS with different feed concentration. The current, voltage and power generation in the reactor is 1.28 mA, 0.9 V and 0.304 watts/m2 respectively.

Keywords: Microbial fuel cell, Paper Mill waste water, Electricity.

Introduction

Rapid urbanization and industrialization in the developing countries like India pose severe problems in collection, treatment and disposal of effluents. This situation leads to serious public health problems .Unmanaged organic waste fractions from industries, municipalities and agricultural sector decompose in the environment resulting in large scale contamination of land, water and air. These wastes not only represent a threat to the environmental quality but also possess a potential energy cane crushed. Because of high value which is not fully utilized despite the fact that they are cheap and abundant on most parts of the world.

Sugar industry generates unwanted residual liquid waste during production and processing of products. Sugar industries generate about 1000 liters of wastewater for every tonne of sugarcane crushed. Because of high BOD content, sugar industry wastewater will deplete dissolved oxygen content of water bodies rendering them unfit for both aquatic life and human uses. Pollution caused by it is one of the most critical environment issue .A number of cleanup technologies have been put into practice and novel bioremediation approaches for treatment of sugar industry's wastewater are being under consideration.

One new promising method for wastewater treatment is the use of microbial fuel cells(MFCs).

Microbial fuel cells (MFC) are unique devices that can utilize microorganisms as catalysts for converting chemical energy into electricity, representing a promising technology for simultaneous energy production and wastewater treatment. MFCs have wider applications including wastewater treatment, production of electricity, bioremediation, hydrogen production, and as environmental sensors .MFCs have been used to treat various kinds of wastewater such as domestic sewage, brewery, distillery ,sugar, paper and pulp, rice mill, swine wastewater and phenolic wastewater. An additional advantage of using MFCs for wastewater treatment is the potential for reducing solids production compared to aerobic processes.

Materials and methodology

Wastewater collection:
Wastewater is collected from nearby sugar industry.

Microbial Fuel Cell(MFC):
Single(MFC) Microbial fuel cell have been fabricated for the treatment of sugar and mill wastewater.

Materials Used For The Fabrication Of MFC:
Various materials used for the construction of MFCs were as follows:

- Three Non-Reactive plastic boxes of seven liters capacity
- Agar
- Pencil leads 2mm Diameter
- Copper wire
- PVC pipe 2cm Diameter
- Sealants
- Multimeter

Functions of the materials used for the fabrication of MFC

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- Plastic box: isused to prepare anodechamber.The anode chamber holds the wastewater.
- Agar:Itis used to prepare agar salt bridge i.e.,proton exchange member for keeping the anode and cathode liquid separate. This membrane is permeable so that protons produced at anode can migrate to the cathode.
- Pencil leads:Theseare used as anode and cathode materials.
- Copper wire:is used to connect the electrodes to the multimeter which form external circuit.
- PVC pipe:holds the agar salt mixture,which is called as agar salt bridge.
- Sealant:PVC pipe was connected to the sides of the plastic boxes and sealed with epoxy.
- Multimeter:is used to measure the current and voltage.

Construction of Microbial Fuel Cell

Step 1:Selection Of Anode Chamber

Non-reactive, non-conductive and non-biodegradable plastic box were selected as anode chamber. The dimensions of plastic box are shown in figure

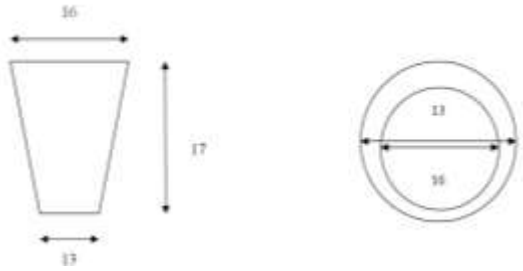

Figure 1:Plasticbox.(All dimensions are in cm)

Step 2: Preparation Of Agar Salt Bridge

The Agar salt bridge was constructed using commonsalt, agar and water.650ml of water was boiled in a beaker,65 grams of agar and75 grams of salt were added to the boiling water,the mixture was further boiled for 3-5minutes.

The mixture is placed in PVC pipe and allowed to solidify and was kept in the refrigerator for 24hours.

Step 3:Assembling Of Electrodes

The graphite rods from pencils have been used as anode and cathode materials.The arrangement of electrodes were done on a plastic pipe in such a way that it looks like a graphite brush as shown in fig.2.The length and diameter of the graphite rods will be 90mm and 2mm respectively.

In MFC, there was no cathode chamber. Instead, the graphite rods from pencils have been placed on agar salt bridge and the copper wire was wound on it. This acted as cathode for MFC. The oxygen in air would help in accepting the electrons from anode chamber. Hole was drilled on the top of anode chamber so that plastic pipe containing the graphite rods can pierce through the hole.

Fig 2:Arrangement of Electrodes

Step 4: Assembling Of Microbial Fuel Cell

MFC reactor were constructed. The assembled electrodes were placed into the anode and cathode chambers, a circular groove was made at the centre of plastic box for fitting the PVC pipe containing agar salt then sealed and made air tight. The reactors are checked for water leakage.

Fig 3:Single chamber MFC

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Results and discussion

General

The characteristics of sugar wastewater and the experimental data relating to single chambered microbial fuel are discussed here.

Characteristics Of Sugar Wastewater

The characteristics of sugar wastewater are presented in table 1.

Table 1: Characteristics of sugar wastewater

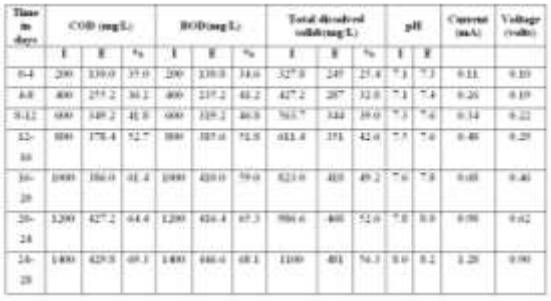
Sl.No	Characteristics	Unit	Sugar Wastewater
1	pH	-	4.35
2	Color	Hazen std unit	Brownish
4	Total dissolved solids	(mg/L)	1330
5	Suspended solids	(mg/L)	1540
6	BOD_5@20ºC	(mg/L)	1040
7	COD	(mg/L)	4647
8	Chlorides	(mg/L)	258

Treatment And Current Generation Using Various Concentrations Of Sugar Wastewater

Sugarwastewater was diluted to get desired feed concentrations. The varied feed concentrations of wastewater were given as the substrate for MFC

The influent(I),effluent(E) and percent removal(%) of chemical oxygen demand,Total dissolved solids and Biochemical oxygen demand for various feed concentrations are presented in tables.

Table 2:Treatment efficiency of sugar wastewater and current generation for various feed concentration



Sugar wastewater showed its potential for COD removal indicating the functions of microbes present in wastewater in metabolizing the carbon source as electron donars. Continuous COD, BOD,TDS removal was observed in MFC. The COD removal efficiency increased from 35% to 69.3%, BOD removal efficiency increased from 34.6% to 68.1% and TDS removal efficiency increased from 25.4% to 56.3% and pH increased from 7.1% to 8.2% randomly, daily pH was brought to neutral for the period 0-28 days.

Current increased from 0.11 to 1.28 mA,Voltage increased from 0.1 to 0.9 V as the feed concentration increases from 200 mg COD/L to 1400 mg COD/L.

COD Removal Efficiency of Sugar wastewater for Various Feed concentrations

Sugar wastewater showed its potential for COD removal indicating the functions of microbes present in wastewater in metabolizing the carbon source as electron donars. It is experimental data that current generation and Cod removal showed relative compatibility. Continuous COD removal was observed in MFC. In MFC, the COD removal efficiency increased from 35% to 69.3% as the feed concentration increase from 200 mg COD/L to 1400 mg COD/L respectively as shown in fig 4.

The COD removal efficiency improved with the increase in feed concentration. COD efficiency for various feed concentrations has been attained equilibrium after 4-5 days with respect to time.

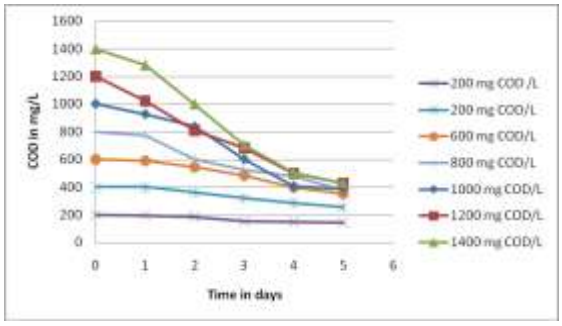


Fig 4: COD Reduction of Sugar wastewater at Various Feed concentrations in MFC

BOD Removal Efficiency of Sugar wastewater for Various Feed concentrations

The BOD of Sugar wastewater was reduced in MFC. BOD was analysed on the first day and final day for each feed concentration. For MFC, the BOD removal efficiency increased from 34.6% to 70.1% as the feed concentration increased from 200 mg COD/L to 1400 mg COD/L respectively as shown in fig 5.

BOD efficiency for various feed concentrations has been attained equilibrium after 4-5 days with respect to time.

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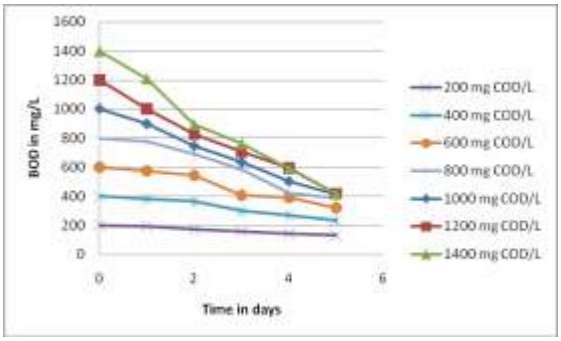

Fig 5: BOD Reduction of Sugar wastewater at Various Feed concentrations in MFC

Total Dissolved solidsRemoval Efficiency of Sugar wastewater for Various Feed concentrations

During the operation considerable reduction in total dissolved solids increased with increase in feed concentration from 200 mg COD/L to 1400 mg COD/L. The total dissolved solids the BOD removal efficiency increased from 25.4%% to 56.3% as the feed concentration increased from 200 mg COD/L to 1400 mg COD/L respectively as shown in fig 6.Total dissolved solids efficiency for various feed concentrations has been attained equilibrium after 4-5 days with respect to time.

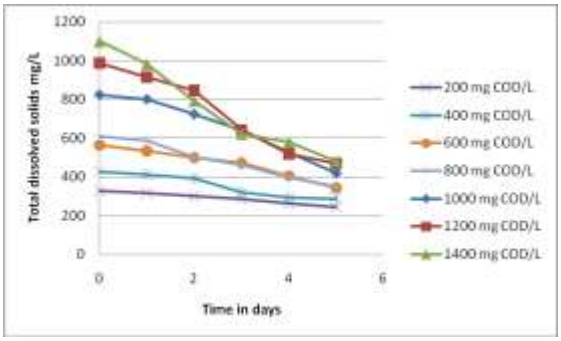

Fig 6: TDS Reduction of Sugar wastewater at Various Feed concentrations in MFC

pH Variation ofSugar wastewater for Various Feed concentrations in MFC

Sugar wastewater showed its potential for increments of pH . Continuous increment was observed in MFC-1, the pH increased from 7.1 to 8.2 as the feed concentration increased from 200 mg COD/L to 1400 mg COD/L respectively as shown in fig 7.

The increment of feed concentration showed a positive effect in increment of pH . pH variation for various feed concentrations has been attained equilibrium after 4-5 days with respect to time.

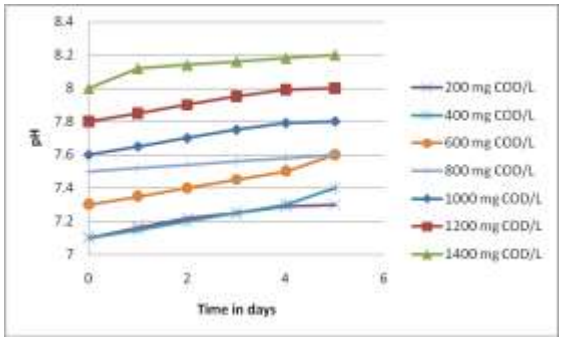

Fig 7: pH Variation of Sugar wastewater at Various Feed concentrations in MFC

Current and voltage Generation of sugar wastewater for various feed concentrations in MFC

The average value of current and voltage for each feed concentration in MFC is given in the fig 8 and fig 9. The current and voltage showed a gradual increase with respect to increase in feed concentration. The highest average values of current obtained 1.28 mA and 0.9V. The power produced for $1m^2$ area is watt. Current and voltage generation for various feed concentrations has been attained equilibrium after 4-5 days with respect to time.

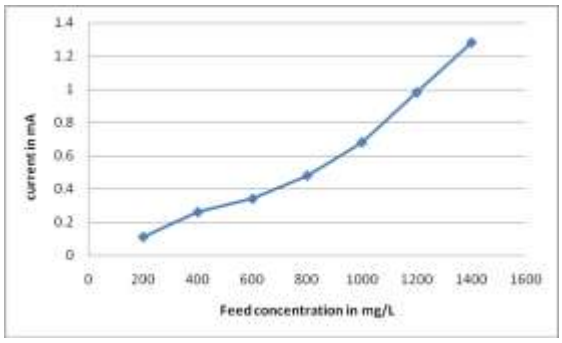

Fig 8.Current Generation of Sugar wastewater at various feed concentrations in MFC

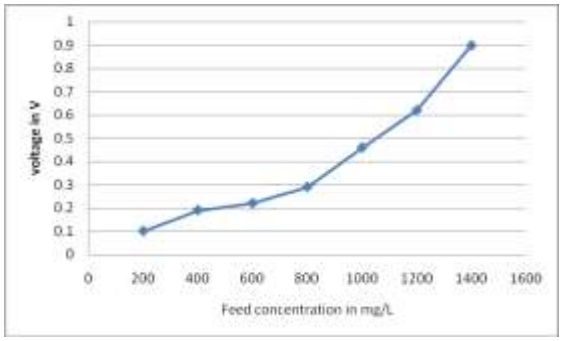

Fig 9.Voltage Generation of Sugar wastewater at various feed concentrations in MFC

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Conclusions

On analyzing the results based on the laboratory experiments conducted, the following conclusion is drawn.

1. MFC of sugar industry wastewater showed removal efficiency 69.3% COD, 68.1% BOD and 56.35 %TDS with different feed concentrations(200-1400 mg COD/L).
2. The current, voltage and power generation in the reactor is 1.28 mA, 0.9 V and 0.304 watts/m^2 respectively. pH was increased randomly from 7.1 to 8.2 with respect to different feed concentration

Acknowledgements

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