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Performance Evaliuation of Microbial Fuel Cell in Treating Industrial Effuelent and Energy Production

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ABSTRACT
The increasing demands of efficient and sustainable energy generation methods from waste products have taken a giant leap in the last century, and especially in the previous two decades. Wastewater treatment has also been a much-researched topic in recent years owing to the exponential increase in effluent-laden wastewater from industries, the agricultural sector and food sector, and its effects on the environment. There have been plenty of wastewater treatment techniques over the years, but most of them lack in terms of cost- effectiveness, durability, and energy recovery rates. Microbial fuel cells can prove to be of great use to tackle both of these issues. As they perform bio electro chemical processes on organic biodegradable compounds to oxidize them to generate power which can be harnessed by various means. This article explains the aim, construction, mechanism, and application of microbial fuel cells; the economic and scientific challenges that they face in the future; and microbial fuel cell (MFC) hybrid systems which make use of MFCs combined with other useful technologies for greater aims and better efficiencies.
The maximum BOD_5 removal efficiency achieved was 55% with an current production of 0.36 to 3.71mA, voltage generation varied from 0.22 to 2.97V.

Keywords: MFC, Organic compounds, Power, Voltage, BOD_5.

1. INTRODUCTION

GENERAL:

In India, the sugar industry plays a significant role in the country's economy and agricultural landscape. It contributes to both rural employment and national GDP. Let's delve into the production figures and waste management practices associated with this industry.

SUGAR PRODUCTION IN INDIA:

India is one of the largest producers of sugar in the world, typically ranking second or third, following Brazil. The production of sugar in India is primarily derived from sugarcane, which is cultivated across

various states, predominantly in the states of Maharashtra, Uttar Pradesh, Karnataka, Tamil Nadu, Gujarat, Andhra Pradesh, and Telangana.

Annually, India produces millions of metric tons of sugar. The exact figures vary from year to year due to factors like weather conditions, government policies, and market demand. However, the production often exceeds 25 million metric tons, sometimes reaching as high as 30 million metric tons in favorable years.

The sugar production process involves several stages. First, sugarcane is harvested from the fields. Then, it undergoes crushing to extract the juice. This juice is then processed to remove impurities and boiled until it crystallizes into sugar. The sugar is then dried and packaged for distribution.

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.

Microbial fuel cells (MFCs) are unique devices that can utilize microorganisms as catalysts for converting chemical energy into electricity under anaerobic condition.

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.

2. MATERIALS AND METHODOLOGY

- Sugar Industry waste water was collected from local Industry Bidar.
- Waste water will be collected by standard methods in 20 letter can and is brought to environmental lab at GNDECB.
- The collected sample will be analyzed “physico chemical” characteristics.

3. Construction of microbial fuel cell.

STEP 1: MICROBIAL FUEL CELL

Two non-reactive plastic containers of a capacity of 5 liters and working volume 3 liters, one bottle is used as distilled water and another is waste water.

One bottle was fed with sugar industry wastewater and another bottle with distilled water. Figure 1 shows the schematic representation of MFC reactors

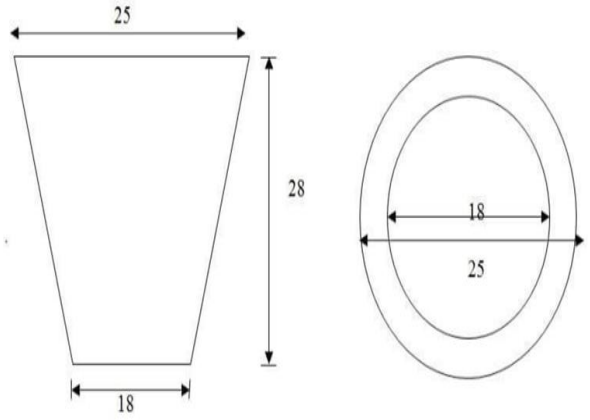

Fig.1: Schematic diagram of Microbial Fuel Cell

STEP 2: Preparation of agar salt bridge

- Common salt, agar, and water is used to make the agar salt bridge.
- In a beaker, 650ml of water is boiled, then 65gm of agar and 75gm of sodium chloride are added and the liquid is cooked for another 3.5 min.
- The prepared slurry is poured into the PVC pipes.
- The setup is let to solidify for a few minutes before being placed in the refrigerator for 24 hours.

Fig.2: Preparation of Agar Salt Bridge

STEP 3: Assembling Of Electrode

Small holes are made in the plastic containers of microbial fuel cells to insert tubes for the wiring to connect to the lead electrode. It's important to seal these holes tightly so that air from outside can't come in. The lead electrode used is about 2mm in diameter and 6cm long.

Fig.3 Lead Electrode

STEP 4: Assembling Of Microbial Fuel Cell

In MFC the completed electrodes are placed into the anode and cathode chambers, Circular holes are created on top covers of two chambers to complete the external circuit. Two more circular holes are created on the sides of the working volume of the centre of the plastic boxes for fitting the PVC tubing carrying agar salt bridge. The plastic boxes are then sealed and made airtight. Water leak is being checked in both reactor.

4. Reactor Operation: -

- **PLASTIC BOXES:** Anode and Cathode chambers are prepared in these boxes. The wastewater is held in the anode chamber, which has a capacity of 5 liters and a working volume of 3 liters, while the conductive salts solution of KCL(Potassium chloride) 3 liter is Poured in the cathode chamber.
- **AGAR AGARBACTO:** In MFC Apart from the Proton exchange System it is also used to keep the anode and cathode liquid separate.
- **LEAD ELECTRODE:** These materials are employed as anode and cathode materials which connects the electrodes to the multi meter, forming an external circuit.
- **PVC PIPE:** The agar salt (NaCl) combination, also known as the agar salt bridge is placed in the PVC PIPE.

Fig.4 Experimental setup of double chamber MFC

5. RESULTS AND DISCUSSION

The effluent from the microbial fuel cell reactor was analyse and the reactor was operated for 24 days, the variation of various parameter such as ph,BOD_5, Production of voltage and current is as shown in the

Parameters	Characteristic Value
Color	Blackish Grey
pH	5.2
Biological oxygen demand (BOD_5)	400 mg/l
Alkalinity	286 mg/l
Total Solids	1045 mg/l
suspended solids	125 mg/l
Dissolved Solids	920mg/l

Table1: Physico chemical characteristics

From the above table it can be stated that sugar industry wastewater is strong and has high BOD_5 values and is highly organic in nature. The reactor was operated for 24 days and the variation in pH, BOD_5 and current production in the reactor is shown in the figures 5, 6 and 7.

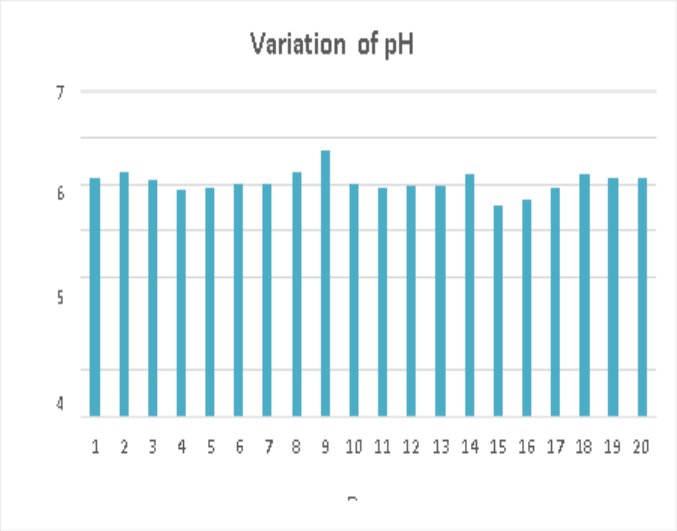

Fig.5: Variation of pH

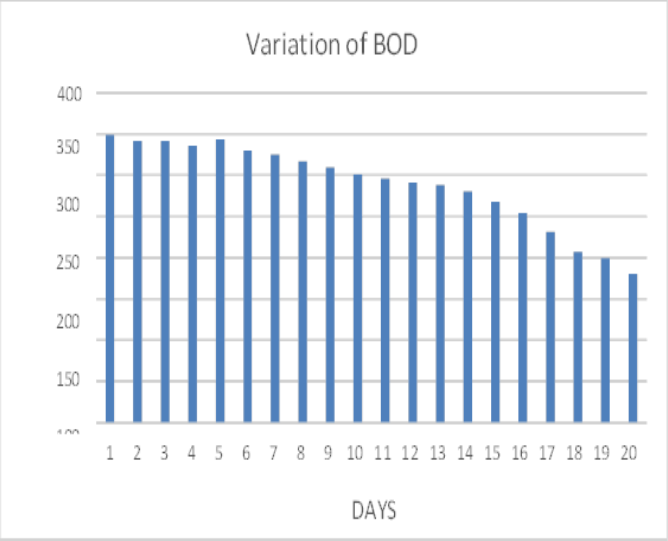

Fig.6. Variation of BOD

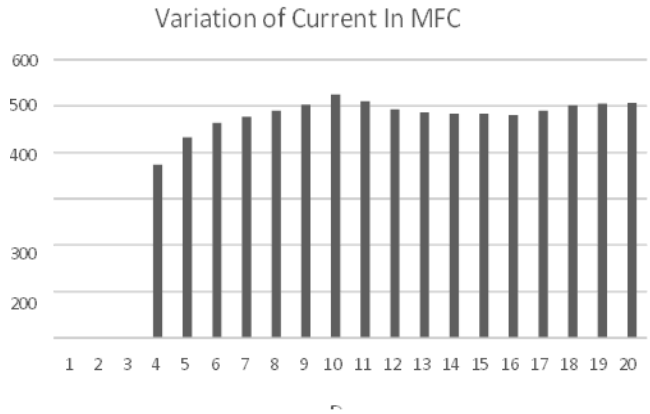

Fig.7. Variation of current in MFC

6. CONCLUSIONS

Sugar wastewater showed its potential for BOD removal indicating the functions of microbes present in wastewater in metabolizing the carbon source as electron donars.

- The maximum BOD_5 Removal Efficiency Obtained is 55%.
- Variation of pH is from 4.5 to 5.7.
- Current increased from 0.36 to 3.71 mA,Voltage increased from 0.22 to 2.97V from 1-24 days.

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