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Research Paper

Applications of Microbial Fuel Cell in Wastewater Treatment of Sugar Industry

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Abstract: *Water pollution is a major global problem. It is caused when contaminants are introduced into the natural environment like lakes, rivers, oceans and groundwater which causes waterborne diseases. Some of the industries which contribute to water pollution are Chemical and Pharmaceutical Industries, Sugar Industries, Steel Plants, Coal, Soap and Detergents, Paper and Pulp Industries, Distilleries, Tanneries, Foods Processing Plants etc. India is the world's largest sugar consuming country and also second largest in sugar production. That's why the amount of wastewater generated from sugar industries has also increased. Wastewater from sugar industries contains carbohydrates, oil and grease nutrients, sulphates, chlorides, and heavy metals. The work was carried out to reduce various pollutants present in synthetic waste water of Sugar Industry using "Microbial Fuel Cell" Treatment Method.*
In the construction of a microbial fuel cell Salt-bridge is the economic alternative to highly priced proton-exchange membrane. By alternating the concentration of agar in the fabrication of slat-bridge, performance of microbial fuel cells were observed using sugar industrial wastewater as the substrate.
Keywords*: Microbial Fuel Cell, Salt bridge, COD, BOD And TDS.*

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I. INTRODUCTION

Rapid urbanization and industrialization in the developing countries like India pose severe problems in collection, treatment and disposal of effluents. This leads to serious public health problems and other environmental problems. Unmanaged organic waste fractions industries, municipalities and agricultural sector decompose in the environment resulting in a large scale contamination of land, water and air. 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.

One of the promising methods for wastewater treatment is the use of microbial fuel cells (MFCs) [1]. In the last few decades MFC have gained importance due to their ability to produce bioelectricity from renewable sources like wastewater and its efficiency. Microbial fuel cells (MFCs) are unique devices that can utilize microorganisms as catalysts for converting chemical energy into electricity under anaerobic condition, representing a promising technology for simultaneous energy production and wastewater treatment [1].Electricity has been generated in MFCs form various organic compounds including carbohydrates, proteins and fatty acids. 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 issues. A number of clean-up technologies have been put into practice and novel bioremediation approaches for treatment of sugar industry’s wastewater are being under consideration.

Generally, there are three outstanding features of the MFC in wastewater treatment, including energy saving, less sludge production as well as less energy production. Many researches have explored the capacity for treating different wastewaters. It has been demonstrated that the MFCs were able to remove multi contaminants, such as biological wastes, heavy metals, polyalcohol, petroleum products dyes, Phenol and phenolic compounds, furan, quinolone, pyridine derivatives. However, for putting MFCs into practice, their performances must be investigated with real wastewater

II. PROCEDURE

Sample collection

The sugar industrial effluent to be bioremediate is collected from the discharge channel outlet of “Sanjivani Sugar Industry Pvt. Ltd” Kopargaon, Ahmednagar District, Maharashtra, India. Before sampling the effluent, the polythene container is clean thoroughly using distilled water. Immediately after the effluent sampling, the effluent sample is taken to the laboratory and store at room temperature in the laboratory for further analysis using standard methods.

MFC Components

MFC majority constitutes electrodes, anodic and cathodic chamber and salt bridge as shown in Fig-1.The salt bridge that forms a bridge between cathodic and anodic chamber facilities the transfer of ions (protons). Carbon and steel rods were used as anode and cathode.

A. Procedure to Prepare Salt Bridge

- Take 100ml of distilled water is in a measuring flask and pour it in a pan. Heat it for certain time until bubbles appear.
- Take 5gms 0f NaCL and pour it in that pan.
- After NaCL is dissolved take 5gms of agar and pour it in the pan, wait until agar powder is dissolved.
- After the agar is dissolved transfer that solution to 10cm PVC pipe, and keep that PVC pipe in a dark place for 24hrs and the agar becomes solidified.
- Repeat the same procedure for 7gms and 10gms agar.

B. Construction of MFC

Figure 1: Construction Of Microbial Fuel Cell

Figure 2: Microbial Fuel Cell for the treatment of waste water

- First we take two 2.5lit boxes and put a hole for both the boxes to attach the PVC pipe.
- Agar was already solidified in the PVC pipe so that we can attach the PVC pipe in middle of the boxes with help of araldite.
- Pour 1lit distilled water in one box which is called as cathode and another 1lit waste water in anode.
- Copper or Stainless steel rods are attached to the electrical wires those electrical wires are connected to the multi-meter, which gives current.
- Run this for 10 days, After the 10 days run completed take the waste water and measure the water-treatment COD.

C. Water quality analysis

Sample was taken from sugar industry waste water and is treated by Microbial Fuel Cells. In the process, two bottles are taken; one bottle was having waste water sample and the other bottle having distilled water. Copper or Stainless steel rods are dipped into each bottle and a salt bridge is attached between two bottles. After the treatment was done samples were taken to determine Chemical Oxygen Demand. The COD was analyzed using closed reflux method. For every 48hrs of operation of the MFC, The outlet was collected and analyzed for the above mentioned parameters

D. Electrical measurements

The current (mA) was measured with a digital multimeter connected to the line between the anode and the cathode. The corresponding current across the resistor was recorded with time.

III. RESULTS AND DISCUSSION

A. General:

The initial BOD and COD concentrations were very high compared to their permissible limits, as prescribed by the Central Pollution Control Board (CPCB), India, for wastewater parameters as shown in Table 1.1. The wastewater was treated under batch mode operation and BOD and COD concentrations were measured before and after treatment. The important operating parameters taken into consideration for the present study were, pH, Molar concentration of salt bridge, different material used as electrodes, varying wastewater concentration and agitation speed, and are described in detail below,

Sr. No.	Parameters	Values	Unit
1	Physical Colour	Dark Brown	-
2	Odour	Unobjectionable	-
3	pH	10.45	-
4	Temperature	24	^{0}C
5	BOD_5, 20^{0}C	7840	Mg/lit
6	COD	16340	Mg/lit
7	TDS	1103	Mg/lit

Table 1.1 Initial Characteristics of Waste water

B. Effect of BOD removal efficiency:

The initial BOD of Sugar wastewater was 7850mg/l. BOD was analysed for 15 days in MFC set up. For MFC, the BOD removal efficiency increased from 9% to 70% BOD removal efficiency was observed in MFC. The maximum voltage produced during the process was 525 mV at 9th day.

Day	BOD (mg/lit.)	% Removal Efficiency	Voltage (mV)
Initial	7840		290
1	7134	09	340
2	6585	16	360
3	6115	22	373
4	5723	27	432
5	5331	32	463
6	4860	38	477
7	4468	43	490
8	4155	47	503
9	3841	51	525
10	3528	55	510
11	3136	60	493
12	2900	63	486
13	2665	66	483
14	2352	68	483
15	2253	70	480

Table 1.2 BOD removal efficiency

The BOD removal efficiency increased from 9% to 70% respectively on 1st day to 15th day. Thus upto 70% BOD removal efficiency was observed in MFC.

C. COD Removal Efficiency:

Sugar wastewater showed its potential for COD removal indicating the functions of microbes present in wastewater in metabolizing the carbon source as electron donors. It is experimental data that current generation and COD removal showed relative compatibility. Continuous COD removal has observed in MFC. In MFC, the COD removal efficiency observed from 8%to 71% on 1st and 15th day respectively. COD efficiency for various feed concentrations has been attained equilibrium after 4-5 days with respect to time. The maximum voltage generated was about 530 mV.

Day	COD(mg/li)	%Removal Efficiency	Voltage(mV)
Initial	16340	00	290
1	15032	08	340
2	13889	15	360
3	13072	20	373
4	12255	25	432
5	11438	30	463
6	10457	36	477
7	9804	40	490
8	8823	46	503
9	8170	50	533
10	7516	54	510
11	7026	57	493
12	6372	61	486
13	5719	65	483
14	5066	69	483
15	4738	71	480

Table 1.3 COD removal efficiency

From Table 1.3 it is observed that in MFC, the COD removal efficiency observed from 8% to 71% on 1st and 15th day respectively.

D. TDS removal efficiency:

The total dissolved solids removal efficiency was observed from 5.25% to 47.46% from 1st day to 9th day of observation respectively. Maximum Voltage generated was 520 mV on 5thday.

Day	TDS (mg/lit)	%Removal Efficiency	Volt. Generate(mV)	Conduct-ivity (mho/cm
1	1045	5.25	290	1492.85
2	943	11.78	320	1390
3	893	19.03	394	1275
4	790	28.37	460	1128.57
5	716	35.08	520	1022.85
6	649	41.16	490	927.14

7	593	46.23	480	847
8	585	46.96	478	835
9	580	47.46	475	828

Table 1.4 TDS removal efficiency

From above Table 1.4 it is observed that the total dissolved solids removal efficiency was observed from 5.25% to 47.46% from 1stday to 9thday of observation respectively. After 7th day, TDS removal efficiency was slow.

IV. Conclusion

The work was carried out to reduce various pollutants present in waste water of Sugar Industry using "Microbial Fuel Cell" treatment method. Various concentrations of agar is taken in a salt bridge like 5gms, 7gms, 10gms, NaCL is also used in salt bridge for the flow of electrons. Two different types of rods such as stainless steel rods and copper rods are used to generate electricity and to reduce the pollutant levels. When the generation of current is increased the amount of pollutants are decreased. After measuring the water treatment COD, we have obtained that 7gms of Agar with stainless steel rods was reducing the more pollutants when compared to 5gms and 10gms agar with copper and stainless steel rods. And the current was also generating more for 7gms agar with stainless steel rods when compared to 5gms and 10gms agar with copper and stainless steel rods. The MFC being a promising resource for the future has to be further investigated for improvements in its performance and capabilities to treat waste water with high organic loads.

References

[1]. Prasad M.P.D, Sridevi V, Ashwini N, Vamsi Krishna Reddy A and Satyanarayana P.A, "Treatment of sugar industry effluents using microbial fuel cells'', " Star Journal", Vol.4(2),pp 247-251, 2015.
[2]. Anand Parkash, "Electricity generation from sugar processing wastewater using environmental friendly dual chamber MFC'', "Journal of Letters In Health and Biological Sciences", vol.1(1), pp 1-6, 2016.
[3]. Mostafa Rahimnejad, Arash Adhami, Soheil Darvari, Alireza Zirepour and Sang-Eun Oh,"MFC as a new technology for bioelectricity generation'', "Alexandria Engineering Journal", Vol.54, pp 745-756, 2015.
[4]. KeChrist Obileke, KeChrist Obileke, Helen Onyeaka, Edson L Meyer and Nwabunwanne Nwokolo, "MFC, a renewable energy technology for bioelectricity generation'', "Journal of Electrochemistry Communications", Vol.125, pp 1-14, 2021.
[5]. Omprakash Sahu, "Sustainable and clean treatment of industrial wastewater with MFC'', "Journal of School of Chemical, Food Engineering, Bahir Dar Institute of Technology, Ethiopia", Vol.1(1), pp 172-185, 2019.
[6]. Sweta Naik and Satya Eswari Jujjavarappu, "Simultaneous bioelectricity generation from cost-effective MFC and water treatment using various wastewater samples'', "Journal of Environmental Science and Pollution Research", Vol.1(1), pp 1-11, 2019.
[7]. Ravindra Kumar, Lakhveer Singh and A.W. Zularisam "Bioelectricity generation and treatment of sugar mill effluent using a MFC'', "Journal of Clean Energy Technologies", Vol.4(4), pp 249-252, 2016.
[8]. Pawel P. Wlodarczyk and Barbara Wlodarczyk "Wastewater treatment and electricity production in a MFC with Cu-B alloy as the cathode catalyst'', " Journal of Catalyst", Vol.1(1), pp 1-13, 2019.
[9]. Ravindra Kumar, L Singh and A. W. Zularism "MFC: Types and Applications'', " Journal Of Reserchgate", Vol.1(1), pp 367-379, 2017.
[10]. G. Rushi Varma, Prof. V. Sridevi, P. Venkat Rao and Shaik Basheerunnisa "Generation of current by using MFC and simultaneously treatment of sugar industrial wastewater'', "International Journal of Engineering Research & Technology" Vol.8, pp 36-40, 2019.
[11]. Sadaf Sarfraz, Ayesha Siddique, Fouzia Qamar, Shahid Raza and Abdul Majeed "A perspective review on methodologies for treating sugar industry effluents'', "International Journal of Engineering Research & Technology", vol.21(4), pp 117-122, 2019.
[12]. Mostafa Abdelshafy Ramadan, Mohamed Hemida Abd-Alla and Usama M. Abdul-Raouf "Bioelectricity Generation from Agro-Industrial Wastewater using dual chambered MFC'', "International Journal of Scientific Research & Engineering Trends" vol.6(1), pp 103-109, 2020.
[13]. Li He, peng du, Yizonhg chen, Hongwei lu, Xi Cheng, Bei chang and zehag wang "Advances in MFC for wastewater treatment'', "Journal of Eleseiver", vol.1(1), pp 1-16,2016.
[14]. M Siddique, A S Jatoi, M H Rajput, S A Soomro, S Aziz, F Mushtaq, G Khan, M A Abro, M Najam Khan, A K Shah and S K Sami "Potential effect of sugar mill wastewater as substrate for bioelectricity generation using laboratory scale double chamber MFC'', "Journal of ICAET", Vol.1(1), pp 1-8, 2018.
[15]. Atikur Rahman, Md Saidul Borhan and Shafiqur Rahman, "Evaluation of MFC for bioelectricity generation and pollutants removal from sugar beet processing wastewater'', " Journal of Water Science & Technology, vol.1(1), pp 388-397, 2018.
[16]. Ke Li, Jingyao Qi Fuguo Zhang, Nicholas Miwornuyunie, Paulette Amaniaampong, Desmond Ato Koomson, Lei Chen, Yu Yan,Yanhong Dong, Victor Edem Setordjie and Abigail Mwin nea Samwini, "The role of wetland plants on wastewater treatment and electricity generation in constructed wetland coupled with MFC'', "Journal of Applied Science", Vol.11, pp 1-14, 2021.
[17]. Swamini Patade, Kris Silveria, Abhilash Babu, Froila D Costa, Yash Mhatre, Vikram Saini, Ritika Rajput, Joice Mathew, Radhika Birmole and Aruna K, "Bioremediation of dye effluent waste through an optimized MFC'', "International Journal of Advanced Research In Biological Sciences", Vol.3(5), pp 214-226, 2016.
[18]. Akshay D. Tharali, "MFC in bioelectricity production'', "Journal of Environmental Science and Pollution Research", Vol.1(1), pp 1-9, 2016.
[19]. Abdul Sattar Jatoi, "Parametric effect of distillery effluent as substrate in MFC for power generation'', " Journal of Application Emerging Science", Vol.1, pp 1-14, 2018.
[20]. Pratibha Singh, Ashima Srivastava and Nupoor Srivastava "Electricity generation by MFC using pulp and paper mill wastewater, vermicompost and Escherichia coil'', " Indian Journal of Biotechnology", vol.16, pp 211-215,2017.