INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN ENGINEERING, SCIENCE & MANAGEMENT

SUSTAINABLE APPROACH TOWARDS WASTEWATER TREATMENT USING MICROBIAL FUEL CELL.

Nishu Dhingra[1], Yogesh C. Rotliwala[2]
Assistant Professor, Chemical Engg. Dept., SNPITRC, Surat, Gujarat, India[1]
Principal, SNPITRC, Surat, Gujarat, India[2]

Abstract*: *Microbial Fuel Cell (MFC) technology represents an alternative way to conventional wastewater treatment. Microbial Fuel Cell represents a new form of renewable energy which converts organic matter into bio-electricity with the help of bacteria present in wastewater. In order to treat the synthetic waste water, authors have studied laboratory scale MFC, demonstrating the effectiveness of the device in respect to waste water treatment i.e. Chemical Oxygen Demand (COD) and organic matter as Biochemical Oxygen Demand (BOD) removal efficiency in the range of 40 to 50%. MFCs represent a potential for waste water treatment and bioenergy production.

Keywords: **Bioelectricity, Microbial Fuel Cell, Waste water.**

INTRODUCTION

Today, growing population and industrialization are exploiting most of the natural resources, in return generating lots of waste. Waste water is one of them. The conventional waste water treatment system consumes significant portion of energy. Therefore, demand for alternative system which requires less energy and recovers most of the energy from waste water to work efficiently is essential now days. Microbial fuel cell (MFC) is considered as an effective solution for sustainable, efficient and alternative source of energy.

Microbial fuel cell (MFC) is a type of bioreactor which converts chemical energy contained in the organic matter of the waste water into the bio-electricity during substrate oxidation by micro-organisms present in waste water. MFCs consist of anode and cathode separated by proton exchange membrane or salt bridge. Substrate is oxidised by micro-organisms in anode chamber, which generates protons and electrons. The electrons are transferred through an external circuit, while the protons diffuse through the solution to the cathode, where electrons combine with protons and oxygen to form water. Various kinds of wastewater can be used as feed for MFCs such as domestic sewage [1,2], brewery [3,4],distillery [5,6],sugar [6],paper and pulp [7], rice mi ll [8], swine wastewater [9]and phenolic wastewater [10]. MFCs have disadvantage, as it involves high costs of materials (platinum catalyst and proton exchange membrane).

In the study authors have tried to study the treatment efficiency of single chambered MFCs at ambient environmental conditions.

MATERIALS & METHODS

A. Electrodes

Graphite electrodes form the HB pencils were used as anode and cathode [11, 12]. The arrangements of the graphite rods for electrodes were made in such a way so as to provide the maximum surface area for the development of biofilm on anode. The length and diameter of the graphite rod were 80 mm and 3mm respectively.

B. Single Chambered Microbial Fuel Cell

Two different single chambered MFC were constructed, using non-reactive plastic containers. Dimensions of the container were 8 x 8 x 12 inches. [6]. Electrodes were connected using the copper wires. In one container (MFC-1) agar salt bridge (5 x 1.5 inches) was used as the proton exchange medium and in other (MFC-2) glass wool (4cm depth) and glass beads (4cm depth). The electrodes were placed in the containers and then made air-tight as shown in figure 1.

C. *Waste Water*

The distillery waste water from local sugar factory was used as substrate and no additional nutrients were supplied for microbial growth. Characteristics of distillery effluent are shown in table 1.

Table 1. Analysis of Distillery Waste Water

Parameter	Value
pH	3.8
Colour	Dark Brown
BOD (mg/L)	19783
COD (mg/L)	70654
Total Solids (mg/L)	1245
Dissolved Solids (mg/L)	3546
Chlorides (mg/L)	765

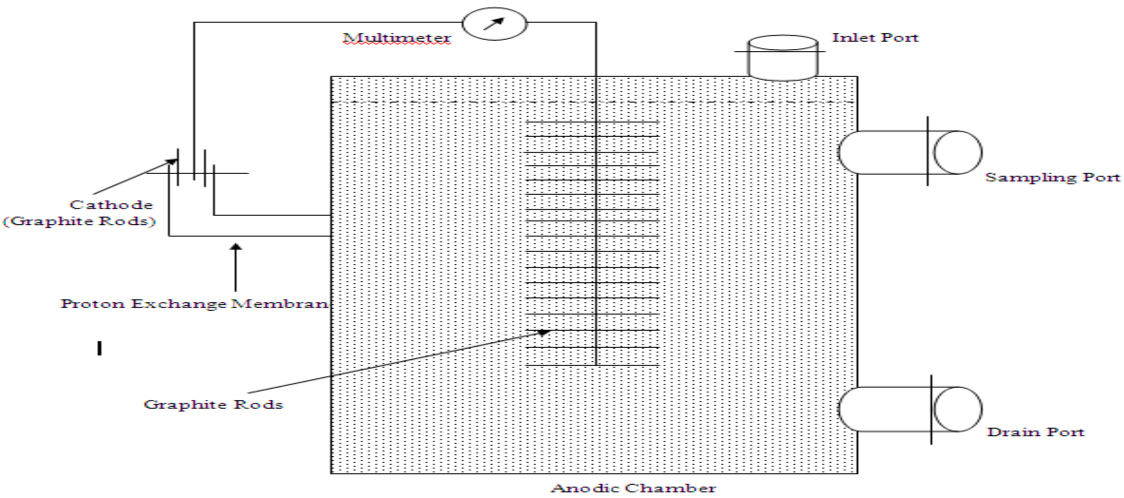

Figure1: Single Chambered Microbial Fuel Cell

D. Experimental Conditions

The anodic chambers of the single chambered MFCs were filled with waste water at ambient environment conditions (27-32°C) so that micro-organisms can grow and colonize around the electrodes and produce bio-electricity. The reactors were kept undisturbed for 24 hours so that it can get stabilized and later on samples were drawn periodically and analysed.

 ISSN : 2394-1766

E. Analysis

After the stabilization of the reactors and experimental conditions samples were withdrawn regularly after every 24 hours and all the parameters (COD, BOD & TDS) were analysed as per IS methods. Voltage and current in the MFCs were measured using a multimeter.

RESULTS AND DISCUSSIONS

The single chambered MFC-1 and MFC-2 were operated in batch mode. MFCs were fed with the same waste water with COD (6.5 g/L), BOD (4.3 g/L) & dissolved solids (3.1 g/l). The change in the waste water concentration showed change in the removal efficiency of the MFCs. The study is under progress for different and higher concentrations of the waste water.

A. *Chemical Oxygen Demand (COD) Removal Efficiency*

The COD removal efficiency after ten days of continuous operation was greater in the MFC-2. Slow and continuous COD removal was observed in both the MFCs indicating the metabolism of the carbon source present in waste water by the microbes. During one week of continuous operation of the MFCs, COD removal efficiency was observed in the range of 40-50%, Whereas COD removal efficiency was observed to increase in case of MFC-2. The observations of the study are in context to the studies carried out by Liu & Logan (2004), Feng et al (2008) and Hampannavar et al (2011).

Table 2. Performance of Mfcs

Days	**COD(mg/L)**		**BOD(mg/L)**		**Dissolved Solids(mg/L)**	
	MFC-1	**MFC-2**	**MFC-1**	**MFC-2**	**MFC-1**	**MFC-2**
0	6500	6500	4300	4300	3100	3100
2	5850	5720	3827	3741	2821	2790
3	5460	5200	3440	3268	2666	2604
4	5070	4355	3225	2967	2418	2458
5	4745	3835	2988	2601	2232	2263
6	4420	3280	2709	2279	2124	2014
7	3770	3190	2408	1935	1906	1891
8	3200	2600	1947	1651	1866	1798

B. *Dissolved Solids Removal Efficiency*

Distillery waste water contains higher concentrations of solids. During the continuous operation of the MFC, considerable reduction in dissolved solids was observed. 40% reduction in the removal of dissolved solids was observed.

C. Biochemical Oxygen Demand (BOD) Removal Efficiency

The BOD removal efficiency after ten days of continuous operation was greater in the MFC-2. Slow and continuous BOD removal was observed in both the MFCs. Bacterias that adhere to the anode surface degrade the organic matter present in the waste water under the anaerobic conditions. As a consequence of degradation protons and electrons are produced. The electrons flow through the circuit and protons pass through the membrane/salt bridge that is connected to cathode. The protons and electrons present react with oxygen on the cathode and become water molecules thereby diluting the waste water. The BOD removal rates were observed in the range of 40-55% in MFC-1whereas it increased from 55 to 62 % in case MFC-2.

IV. CONCLUSION

The study demonstrated that the single chambered MFC-2 was more economically feasible, reliable and efficient in the reduction of COD & BOD levels and concurrently generating bio-electricity also. Both the reactors exhibited stable operation.

REFERENCES

[01] Y. Ahn and B. E. Logan, "Effectiveness of domestic wastewater treatment using microbial fuel cells at ambient and mesophilic temperatures", Bioresource Technology, 2010, vol. 10, pp 469-475.

[02] H. Liu, R. Ramnarayanan and B. E. Logan, "Production of electricity during wastewater treatment using a single chamber microbial fuel cell", Environmental Science and Technology, 2004, vol. 38, pp 2281-2285.

[03] Y. Feng, X. Wang, B. E. Logan and H. Lee, "Brewery wastewater treatment using air-cathode microbial fuel cells", Applied Microbiology and Biotechnology, 2008, vol. 8, pp 873-880.

[04] S. M. Abhilasha and V. N. Sharma, "Bioelectricity production from various wastewaters through microbial fuel cell technology", Journal of Biochemical Technology, 2009, vol. 2(1), pp 133-137.

[05] G. Mohankrishna, S. Venkatamohan and P. N. Sharma, "Bio-electrochemical treatment of distillery waste water in microbial fuel cell facilitating decolorization and desalination along with power generation", Journal of Hazardous material, 2010,vol. 177, pp 487-494.

[06] U. S. Hampannavar, Anupama and N.V. Pradeep, "Treatment of distillery waste water using single chamber and double chambered MFC", International Journal of Environmental Sciences, 201, vol. 2(1), pp 114-123.

[07] L. Huang and B. E. Logan, "Electricity generation and treatment of paper recycling wastewater using a microbial fuel cell", Applied Microbiology and Biotechnology, 2008, vol. 80, pp 349–355.

[08] M. Behera, P. S. Jana, T. T. More and M.M. Ghangrekar, "Rice mill waste water treatment in microbial fuel cells fabricated using proton exchange membrane and earthern pot at different pH", Bioelectrochemistry, 2010, vol. 79, pp 228-233.

[09] J. E. Kim, J. Dec, M. E. Bruns, B. E. Logan, " Reduction of odors from swine waste water by using Microbial Fuel Cells", Applied and Environmental Microbiology, 2008, vol. 74(8), pp 2540-2543.

[10] H. Luoa, G. Liua, R. Zhanga, S. Jin," Phenol degradation in microbial fuel cells", Chemical Engineering Journal, 2009, vol. 147, pp 259-264.

[11] B. E. Logan and J. M. Regan, "Microbial Fuel Cells- Challenges and Applications", Environmental Science & Technology, 2006, vol. 40, pp 5172-5180.

[12] B. E. Logan, S. Cheng, V. Watson and G. Estadt, " Graphite Fibre Brush Anodes for Increased Power Production in Air-Cathode Microbial Fuel Cells", Environmental Science & Technology, 2007, vol. 41, pp 3341-3346.

 ISSN : 2394-1766