International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 6 Issue 2|| February 2017 || PP. 54-59

Treatment of Blended Wastewater Using Single Chamber and Double Chambered MFC

Shashikant.R.Mise [1] and Vandana.V.Mane [2]
[1]*Professor, Department of Civil Engineering,PDA College of Engineering Gulbarga. Karnataka. INDIA*
[2]*M.Tech Scholar, Department of Environmental Engineering, PDA College of Engineering Gulbarga. Karnataka .India*

Abstract: *Microbial fuel cell is used for treatment of Blended wastewater (i.e.,dairy and distillery blended wastewater) for generation of electricity. Blended wastewater is treated in microbial fuel cell in ambient room temperature. In this study single chamber and double chambered MFC was used for the treatment of blended wastewater and generation of electricity. Micro-organisms present in blended wastewater and cow dung was used as inoculum, and blended wastewater acted as substrate. Single chamber MFC (MFC-1) and double chambered MFC (MFC-2) produced a maximum current of 7.99mA, 6.54mA and voltage of 6.54volts, 5.96volts.The power generation of MFC-1 and MFC-2 was 4.58W/m^2 and 3.419W/m^2. MFC-1 was efficient in the removal of COD 84.77% and dissolved solids removal of 73.51% whereas, in case of MFC-2 the COD removal was 77.25% and dissolved solids removal was 72.23%. Different concentrations were loaded in MFC-1 and MFC-2 with the increment of the feed concentrations of COD. The COD and dissolved solids removal observed in dairy wastewater is attributed to the microbial catalyzed electrochemical reactions occurring in the anodic chamber of single and double chambered MFC.*

Key Words: *Microbial Fuel Cell (MFC), Bioelectricity, Distillery and Dairy wastewater, Organic waste, Energy recovery.*

I. Introduction

Organic wastes released from many process industries are of prime concern to the environment. Their handling, treatment and disposal are the major challenges to such industries. Dairy and distillery wastewater is unwanted residual liquid waste generated during alcohol production and pollution caused by it is one of the most critical environmental issue. This possess severe threat to human health and environment when not managed properly. A number of cleanup technologies have been put into practice and novel bioremediation approaches for treatment of dairy and distillery wastewater are being worked out. Anaerobic produces small amount of sludge and energy can be recovered (i.e.,[1])

Microbial Fuel Cells (MFC) are unique devices that can utilize microorganisms as catalysts for converting chemical energy directly into electricity, representing a promising technology for simultaneous energy production and wastewater treatment (i.e.,[2,3]). In MFC electrons generated in anode cell reach the cathode and combine with protons that diffuse from anode through the membrane or agar salt bridge (i.e.,[3,4]).

MFC's have wider applications including wastewater treatment, production of electricity, bioremediation, hydrogen production, and as environmental sensors (i.e.,[3]). MFCs have been used to treat various kinds of wastewater such as dairy (i.e.,[5,6,7]), etc. and brewery (i.e.,[8,9]), distillery (i.e.,[9]), sugar (i.e.,[10]) etc. An additional advantage of using MFCs for wastewater treatment is the potential for reducing solids production compared to aerobic processes (i.e.,[11])

Objectives of the current study is to fabricate the single chamber and double chambered microbial fuel cell and to study the treatment efficiency with respect to COD and dissolved solids reduction. To study the effect of varied feed concentrations of wastewater and generation of electricity in single chamber and double chambered microbial fuel cell.

II. Materials And Methods

Electrode Materials

Graphite rods from pencils were used as both anode and cathode (i.e.,[3]). The arrangement of the graphite rods was made in such a way as to provide the maximum surface area for the development of biofilm on anode. The length and diameter of the graphite rods were 90mm and 2mm respectively. Pre-treatment was not provided for the electrode materials

MFC Reactor

MFC-1 and MFC-2 reactor were constructed. The reactors were constructed using non-reactive plastic containers with dimensions of 13x16x17 cm. The electrodes were connected by using copper wire. The agar salt bridge was used as the proton exchange medium (i.e.,[12])). The electrodes were placed in the chambers, then were sealed and made air tight.

Single Chamber MFC

A plastic container was used as the anode chamber. The agar salt bridge was joined to anode chamber. The length and diameter of agar salt bridge was 10cm and 2cm respectively as shown in Fig 2. The graphite rods were placed on the agar salt bridge and left open to air which is acted as cathode.

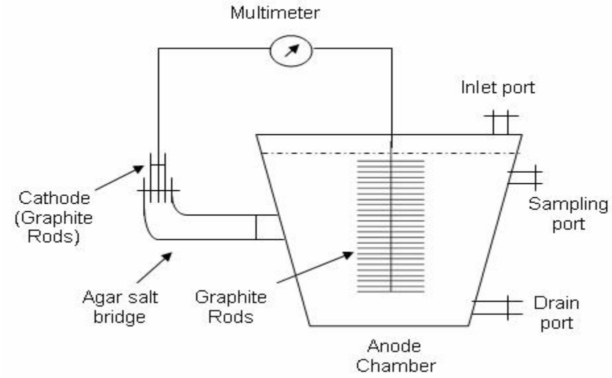

Figure 1: Single chamber MFC

Double Chambered MFC

Two non-reactive plastic containers were used for Double chambered MFC. One plastic container was used as anode chamber (to be fed with wastewater) and the other as cathode chamber as shown in Figure 2. 2 liters of wastewater was fed to the anode chamber and 2 liters of Potassium permanganate (catholyte) was fed to the cathode chamber. The cathode and anode chambers were connected using agar salt bridge. The length and diameter of agar salt bridge is 10 cm and 2 cm respectively.

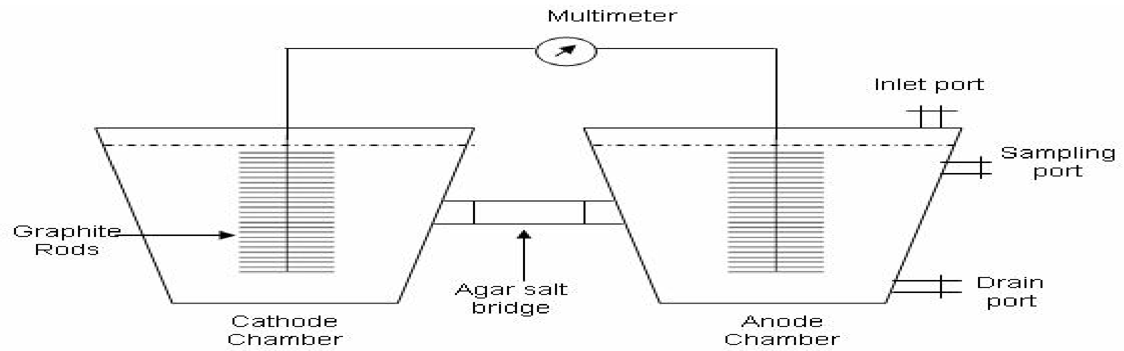

Figure 2: Double chambered MFC

Dairy Wastewater and Microbial Inoculum

The blended wastewater was used as substrate and cow dung as source of inoculum. No any additional nutrients were given for micro-organisms except the nutrients present in the blended wastewater

Table 1: Characteristics of dairy wastewater

SL.No.	Characteristics	Unit	Dairy Wastewater	Distillery Wastewater
1	Ph	-	6.8	4.1
2	Colour	Ppm	Whitish	Dark Brown
3	Total Solids	(mg/L)	2856	64033
4	Total Dissolved Solids	(mg/L)	2074	49733
5	Suspended Solids	(mg/L)	782	12300
6	BOD_5@ 20^0C	(mg/L)	1240	46666
7	COD	(mg/L)	1868	64833
8	Chlorides	(mg/L)	232	4934

III. Results And Discussions

The MFC-1 and MFC-2 were run parallel. The whole study was conducted under ambient environmental conditions. The anode chamber was filled with blended wastewater so that micro-organisms in the wastewater could colonize the electrodes and produce electricity. The samples were drawn from the chambers periodically and analyzed. When the reactor reached steady state conditions, the reactor was loaded with blended wastewater of higher concentration. Different feed concentrations were given for MFC-1 and MFC-2. The increase in feed concentration showed a positive effect on current and voltage.

COD removal efficiency

At every increment in feed concentration, the improvement in COD removal efficiency was observed. Blended wastewater showed its potential for COD removal indicating the function of microbes, present in wastewaters in metabolizing the carbon source as electron donors. It is evident from experimental data that current generation and COD removal showed relative compatibility. Continuous COD removal was observed in the MFC-1 and MFC-2. In MFC-1 COD removal efficiency increased from 28.68% to 84.77% and in case of MFC-2 COD removal efficiency increased from 26.06% to 77.25% as the feed concentration increased from 5000 mg COD/L to 40000 mg COD/L respectively as shown in Figure 3 and 4.

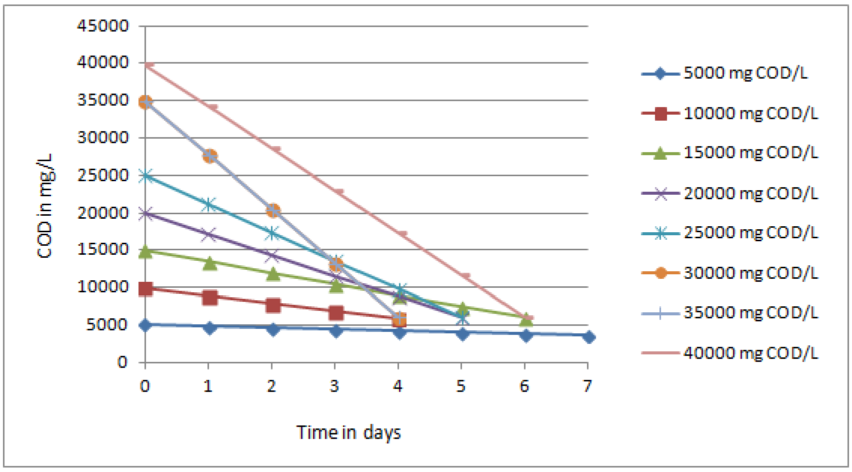

Figure 3: COD reduction at various feed concentrations in MFC-1.

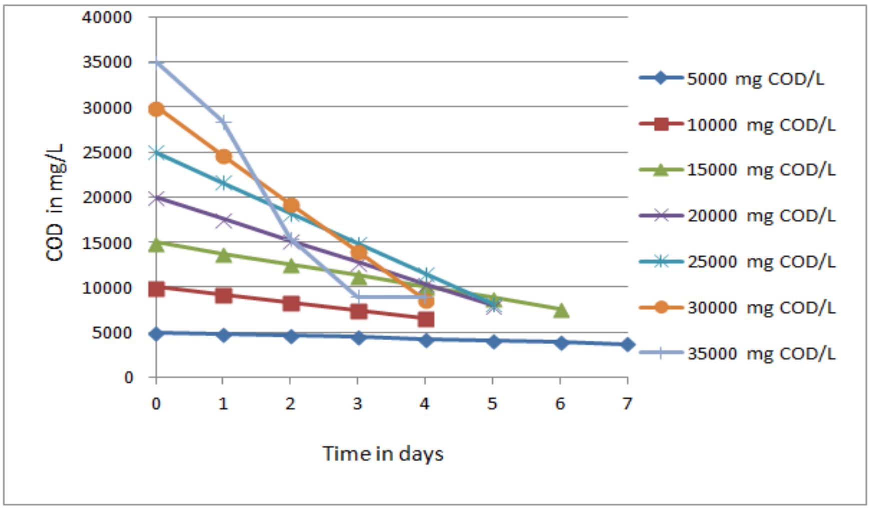

Figure 4: COD reduction at various feed concentrations in MFC-2.

Dissolved solids removal efficiency

Dairy-based wastewater characteristically contains higher concentration of solids. During the operation considerable reduction in dissolved solids concentration was observed in MFC-1 and MFC-2. The reduction of dissolved solids increased with the increase in the feed concentrations as shown in Figure 5. As the feed concentration were increased from 5000 mg COD/L to 40000 mg COD/L. The dissolved solids removal efficiency increased in MFC-1 and MFC-2 are from 38.67% to 73.51% and 30.76% to 72.23% respectively as shown in Figure 5 and 6.

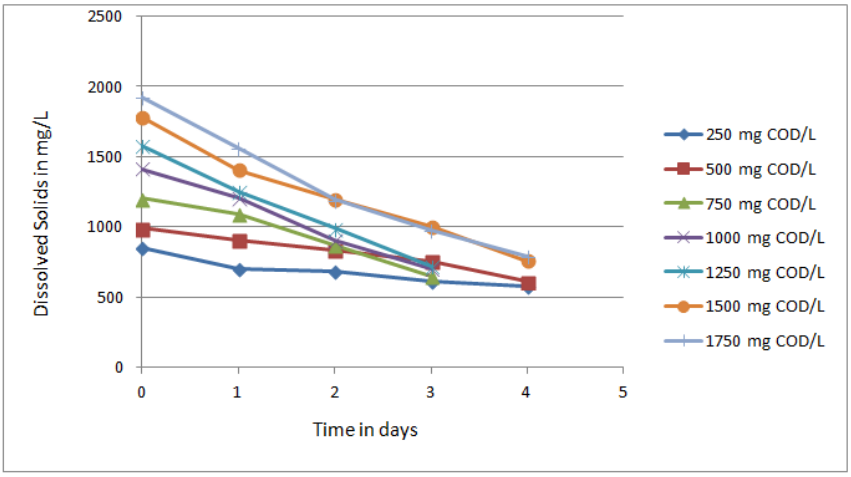

Figure 5: Dissolved solids reduction at various feed concentration in MFC-1

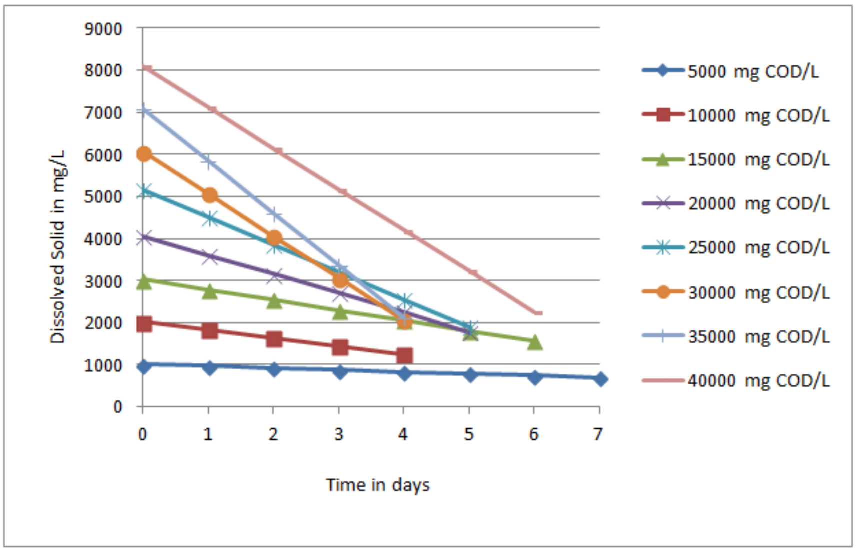

Figure 6: Dissolved solids reduction at various feed concentration in MFC-2

Current and Voltage

The average values of current and voltage for each feed concentration are given in the Figure 4 and Figure 7, 8, 9, and 10. The current and voltage showed a gradual increase with respect to the increase in feed concentration. MFC-1 and MFC-2 produced a maximum current of 7.99mA, 6.54mA and voltage of 6.54volts, 5.96volts.The power generation of MFC-1 and MFC-2 was 4.58W/m^2 and 3.419W/m^2. The similar observation was reported during the treatment of blended wastewater (i.e.,[9]).

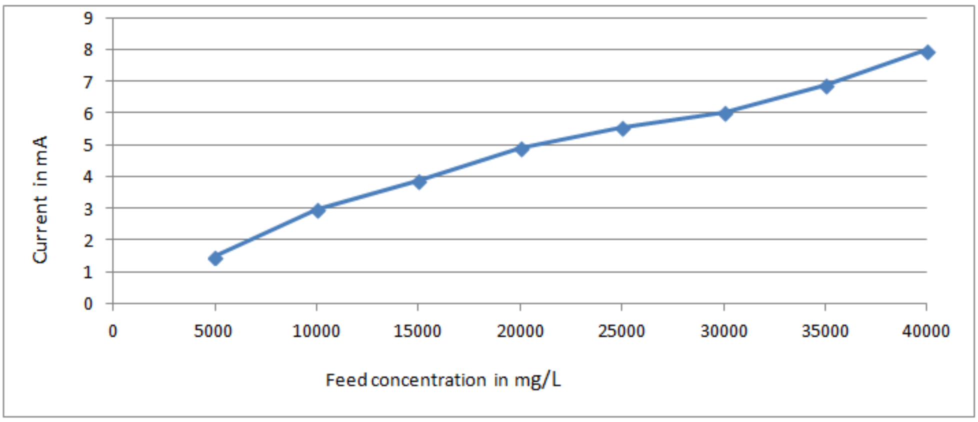

Figure 7: Current generation at various feed concentrations inMFC-1.

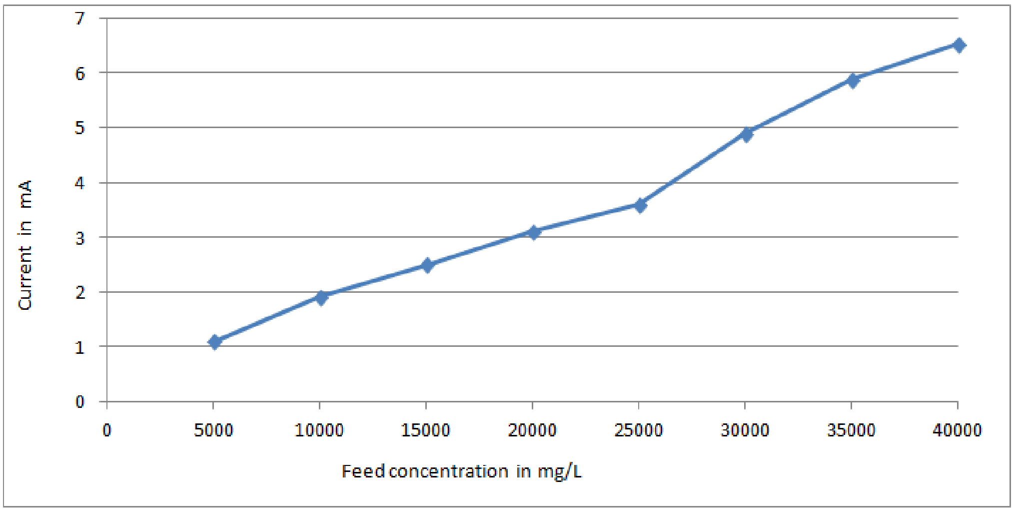

Figure 8: Current generation at various feed concentrations inMFC-2.

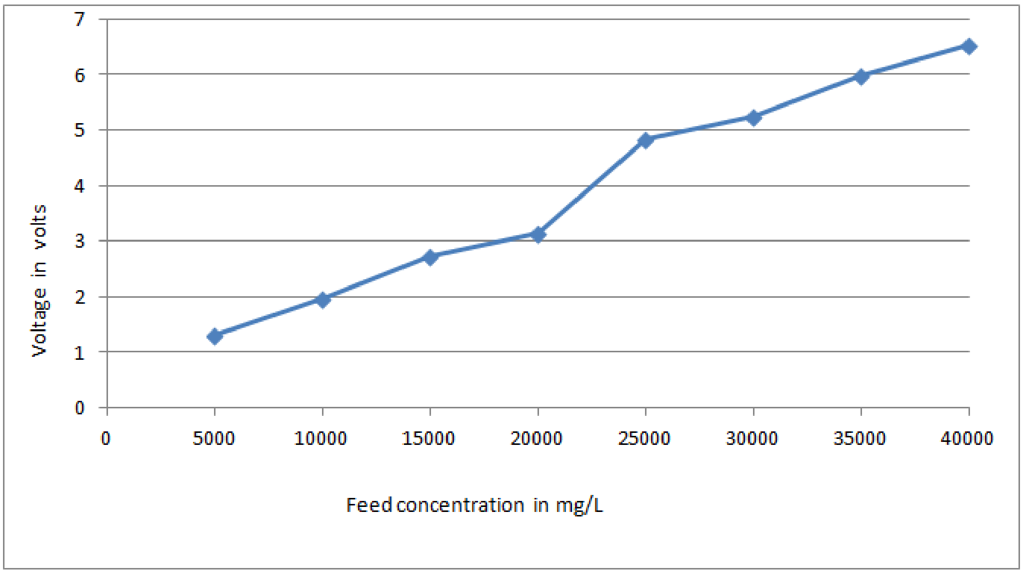

Figure 9: Voltage generation at various feed concentrations in MFC-1

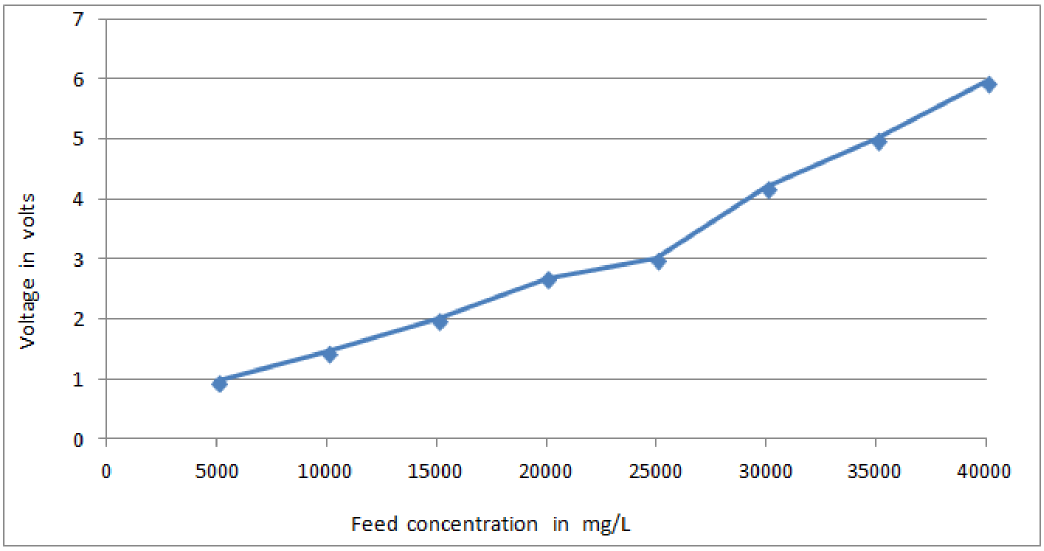

Figure 10: Voltage generation at various feed concentrations in MFC

The current and voltage were much higher in MFC-1 when compared with MFC-2. Logan *et al.*, (2007 have reported the advantages of air cathode MFC (compared with cathode suspended in water) as oxygen transfer to the cathode occurs directly from air, and thus oxygen does not have to be dissolved in water. The abundant electron acceptors i.e., oxygen availability in air is the reason for the higher current generation.

IV. Conclusions

The study demonstrated effective treatment of blended wastewater of different feed concentrations from 5000 mg COD/L to 40000 mg COD/L simultaneously generating electricity.COD removal efficiency increased in MFC-1 and MFC-2 from 28.68% to 84.77% and 26.06% to 77.25% and dissolved solids removal efficiency increased in MFC-1 and MFC-2 from 38.67% to 73.51% and 30.76% to 72.23% feed concentration increased from 5000 mg COD/L to 40000 mg COD/L respectively. The current showed a gradual increase in MFC-1 and MFC-2 from 1.48 mA to 7.99mA and 1.10mA to 6.54mA and voltage showed a gradual increase in MFC-1 and MFC-2 from 1.30volts to 6.54volts and 0.96volts to 5.96volts respectively with increase in feed concentration. The power generation in MFC-1 and MFC-2 was 4.58watts/m^2 and 3.419watts/m^2

Acknowledgement

Ever since my entry into this program, till the submission of this project, it was memorable event and lifetime experience. With deep sense of respect and thankfulness, I would like acknowledge my gratitude towards my project guide Dr.S.R.MISE Professor and PG Co-Ordinator Civil Engineering Department, PDA College of Engineering Gulbarga,Karnataka. INDIA.

He introduced me to this vast field of project and has been the inspiration behind this work. His patience, empathy and constant encouragement contributed to my sojourn for my work being most happy and memorable one. It is with great pleasure that I acknowledge the unflinching love and moral support of my parents for having stood by me all along.

References

[1]. Hampannavar U. S and Shivayogimath C.B., (2010). "Anaerobic treatment of sugar industry wastewater by upflow anaerobic sludge blanket reactor at ambient temperature", International Journal of Environmental Sciences, 1(4), pp 631-639.

[2]. Liu H and Logan B. E., (2004). "Electricity Generation Using an Air- Cathode Single Chamber Microbial Fuel Cell in the pressure and Absence of a proton Exchange Membrane", Environmental Science and Technology, 38, pp 4040-4046.

[3]. Logan B. E and Regan J. m., (2006). "Microbial fuel cells – challenges and applications", Environmental Science and Technology, 40, pp 5172-5180.

[4]. Min B and Logan B E., (2004), "Continuous Electricity Generation from Domestic Wastewater and Organic Substrates in a Flat Plate Microbial Fuel Cell", Environmental Science and Technology, 38, pp 5809-5814.

[5]. Sengil, A. and Ozacar, M. "Treatment of dairy wastewaters by electrocoagulation using mild steel electrodes", Journal of Hazardous Materials. B137, 2006, pp. 1197 – 1205.

[6]. Roa. M. and Bhole, A.G., "Removal of organic matter from dairy industry wastewater using low cost adsorbents". Journal of Indian Chemical Engineering. Section A44(I), 2002, pp. 25-28.

[7]. Frappart, M., Akoum, O., Ding, L. H., and Jaffrin, M. Y., "Treatment of dairy process waters modelled by diluted milk using dynamic nanofiltration with a rotating disk module", Journal of Membrane Science, 282, 2006, pp. 465-472.

[8]. Feng Y, Wang X, Loagan B.E and Lee H, "Brewery Wastewater Treatment using Air Cathode Microbial Fuel Cells", Applied Microbiology and Biotechnology, Vol. 78, 2008, pp. 873-880.

[9]. Mohanakrishna G., Venkata Mohan S., Sarma P.N., (2010). "Bio-electrochemical treatment of distillery wastewater in microbial fuel cell facilitating decolorization and desalination along with power generation", Journal of Hazardous Material, 177, pp 487-494.

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

[11]. Ahn Y and Logan B. E., (2010). "Effectiveness of domestic wastewater treatment using microbial fuel cells at ambient and mesophilic temperatures", Bioresource Technology, 101, pp 469-475.

[12]. Momoh O. L and Naeyor B.A., (2010). "A novel electron acceptor for microbial fuel cells: Nature of circuit connection on internal resistance", Journal of Biochemical Technology, 2(4), pp 216-220.