USING MICROBIAL FUEL CELL TECHNOLOGY TO WASTEWATER TREATMENT AND GENERATE ELECTRICITY

A.R GAIKWAD, *PG Scholar*, Dr.M.V JADHAV *(Guide)*

Sanjivani College of Engineering Kopargaon.
Department of Civil Engineering,

ABSTRACT

New approach to wastewater treatment along with production of sustainable clean energy by Microbial Fuel Cells technology.The increase in energy demand can be fulfilled by Microbial Fuel Cell in future. In previous years, researchers have shown that MFCs can be used to produce electricity from water containing glucose, acetate or lactate. Studies on electricity generation using organic matter from the wastewater as substrate are in progress. Waste biomass is a cheap and relatively abundant source of electrons for microbes capable of producing electrical current outside the cell. Production of energy resource while minimizing the waste is one of the best ways for sustainable energy resource management practices. Application of Microbial Fuel Cells (MFCs) may represent a completely new approach to wastewater treatment with production of sustainable clean energy.

Keyword : - *Microbial Fuel cell, bioelectricity, wastewater, salt bridge.*

1.INTRODUCTION

While the world population is growing, energy and water resources are becoming limited. These issues are causing concerns about global food security for the first time since the Green Revolution of the 1960's.
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.

2. LITERATURE REVIEW

1. B.G. Mahindra and Shridhar Mahavarkar studied the microbial fuel cell technology and were able to treat domestic and dairy wastewater successfully, and microorganisms present in the wastewater are used for electricity generation and found that COD & TDS single chamber air cathode MFC proves to be more reliable because of the reduced cost of construction, low maintenance and higher electricity generation when compared with double chambered MFC.
2. Doddamani K.R. and Mise S.R studied that 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.
3. Smita Raghuvanshib et.al found that the assessment of a waste water treatment plant at a university campus. It has been found that the electricity required carrying out the whole treatment process. (Water collection, sludge activation, treatment, purification, and re-distribution) has the highest impact in all assessment categories. It has also

been observed that the use of treated water for irrigation purpose is mitigating the impact generated by the treatment process to a large extent and ultimately decreases the environmental burden.

2.1 Wastewater Sampling from Nallha-

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3. Materials and Methodology

MFC Chamber Material-

Following are the name and description of the components used for the design of cell:

1. Cathode Chamber-
The cathode chamber consist of plastic container of volume 10 lt.which is non-reactive, non-conducting and holds the Electrode in an aqueous solution. The final reaction reduction of oxygen occurs in this chamber.
2. Cathode Electrode-
The Cathode electrode is composed of 1.graphite lead which is 2mm diameter, and 7.5 cm long.
2.Aluminium mesh Electrode 3.Copper Electrode 4.Carbon electrode. These electrodes were use one by one at 12 days of interval.
3. Salt Bridge-
Since Proton Exchange Membranes are very expensive and fragile, an agar salt bridge was used. The salt bridge is prepared by taking 50ml of distilled water in a beaker, heat it till boiling, then add 20gm KCl to it, stir well till KCl is dissolved, now add 15gm agar and stir continuously so that all the filaments gets break and even viscous solution is formed. [] Fill this solution in a 1" diameter and 10 cm long PVC pipe by keeping on side closed. Keep this filled pipe in refrigerator so that it can be used.
4. Anode Chamber-
The anode chamber consist of plastic container of volume 10 lt. which is non-reactive, non-conducting and contains the electrode immersed in inoculated media. This chamber is completely sealed off from the outside environment by means of a wax and cello tape.
5. Anode Electrode-
The anode electrode is also of graphite which is 2 mm diameter, and 7.5 cm long. 2.Aluminium mesh Electrode 3.Copper Electrode 4.Carbon electrode. These electrodes were use one by one at 12 days of interval.
6. Multimeter-
During the process the output in the form of voltage was measured using the Digital multimeter.
7. Circuit Assembly-
Two chambers were internally connected by salt bridge and externally the circuit was connected with copper wires which were joined to the two electrodes at its ends and to the multimeter by another ends.

3.2 MFC Fabrication

One double chambered MFC reactor was fabricated. The reactor was fabricated using non-reactive plastic containers with total volume of 10 liters and the working volume was 7 liters. 1. Graphite rods from pencils 2.Aluminium mesh Electrode 3.Copper Electrode 4.Carbon electrode were used as both anode and cathode materials. The arrangement of graphite rods (75 mm in length & 2mm in diameter) was made in such a way as to provide the maximum surface area for the development of biofilm on anode. [2] The electrodes were connected using copper wire. The anode and the cathode chambers were separated by proton exchange membrane (agar salt bridge). The length and diameter of the agar salt bridge is 5 inches and 1.5 inches respectively. The electrodes were placed in the chambers then were sealed, made airtight and were checked for water leakages. filled with KCL solution (catholyte). The internal wiring of anode and cathode was connected to a multimeter to complete the circuit. The entire setup was left for 1 hr for stabilization and the reading in the multimeter was noted down every 24hrs for 12 days of operation.

Fig. 2 Double chambered MFC

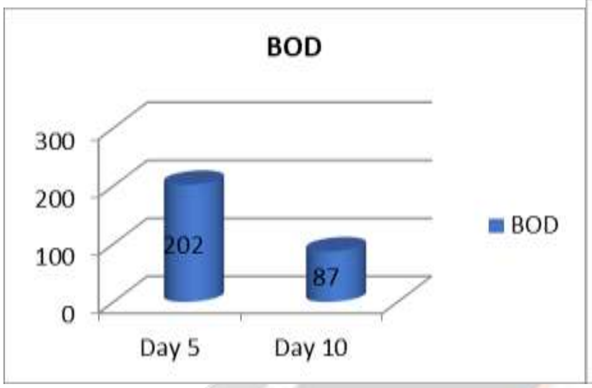
4. Results and Discussion

Table 4.1 Effect of variation of Electrode material (Graphite leads) for BOD,COD,Ph,TDS Microbial fuel Cell for Domestic Waste water.

(Initial BOD-260 mg/l, Initial COD- 673 mg/l)

<table>
<tr><th>Days (Treatment)</th><th>BOD Removal (%)</th><th>COD Removal (%)</th><th>TDS Removal (%)</th><th>pH</th></tr>
<tr><td>Day 1</td><td rowspan="5">23.61 (5th day)</td><td>00</td><td>00</td><td>5.83</td></tr>
<tr><td>Day 2</td><td></td><td>2.59</td><td>5.86</td></tr>
<tr><td>Day 3</td><td>9.36</td><td>4.81</td><td>6.5</td></tr>
<tr><td>Day 4</td><td></td><td>10.00</td><td>6.2</td></tr>
<tr><td>Day 5</td><td>39.67</td><td>13.33</td><td>7.24</td></tr>
<tr><td>Day 6</td><td rowspan="5">75.76 (10th day)</td><td></td><td>20.37</td><td>7.40</td></tr>
<tr><td>Day 7</td><td>49.47</td><td>23.33</td><td>7.70</td></tr>
<tr><td>Day 8</td><td></td><td>33.70</td><td>7.79</td></tr>
<tr><td>Day 9</td><td>54.53</td><td>38.15</td><td>7.86</td></tr>
<tr><td>Day 10</td><td></td><td>39.63</td><td>7.90</td></tr>
</table>

Day 11	-	**58.54**	**40.74**	**7.75**
Day 12	-		**42.96**	**8.14**



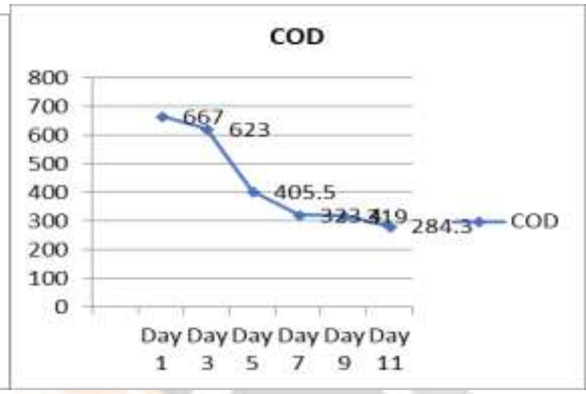


Fig.3 Days vs BOD variation graph

Fig.4 Days vs COD variation graph

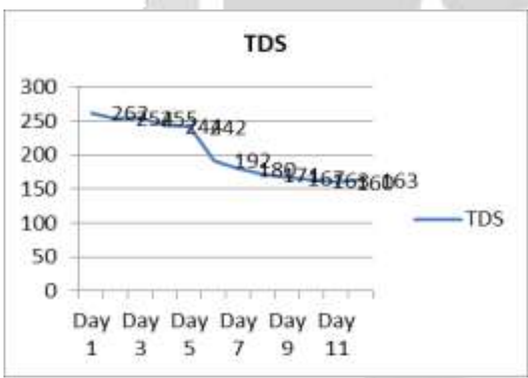


Fig.5.13 Days vs TDS variation graph

Fig.5 Days vs pH variation graph

Table 4.2 Effect of variation of Electrode material (Aluminium mesh) for BOD,COD,Ph,TDS Microbial fuel Cell for Domestic Waste water. (Initial BOD-274 mg/l, Initial COD- 698 mg/l)

Days (Treatment)	BOD Removal (%)	COD Removal (%)	TDS Removal (%)	pH
Day 1	0.047 (5th day)	0	0	6.83
Day 2			2.94	5.86
Day 3		3.44	5.15	6.53
Day 4			6.25	6.23
Day 5		40.69	11.76	7.24
Day 6	46.71 (10th day)		12.50	7.40
Day 7		44.99	19.12	8.70
Day 8			25.00	7.70
Day 9		45.85	30.15	8.86
Day 10			31.25	8.90
Day 11	-	50.14	36.03	9.75
Day 12	-		36.76	10.14

Table 4.3 Effect of variation of Electrode material (copper mesh) for BOD,COD,Ph,TDS Microbial fuel Cell for Domestic Waste water. (Initial BOD-202 mg/l, Initial COD- 667mg/l)

Days (Treatment)	Final BOD (mg/l)	BOD Removal (%)	COD Removal (%)	TDS Removal (%)	pH
Day 1	202 (5th day)	26.27	0.00	00	7.83
Day 2				3.05	5.86
Day 3			6.60	2.67	7.5
Day 4				6.87	6.2
Day 5			39.21	7.63	7.24
Day 6	87 (10th day)	68.24		26.72	7.4
Day 7			51.51	31.30	7.7
Day 8				34.73	7.79
Day 9			52.17	36.26	8.86
Day 10				37.79	8.9
Day 11	-	-	57.38	38.93	9.7
Day 12	-	-		37.79	10.46

Table 4.4 Effect of variation of Electrode material (Aluminium mesh) for BOD,COD,Ph,TDS Microbial fuel Cell for Domestic Waste water.

(Initial BOD-264 mg/l, Initial COD- 686 mg/l)

Days (Treatment)	BOD Removal (%)	COD Removal (%)	TDS Removal (%)	pH
Day 1	37.12 (5th day)	0.00	00	6.83
Day 2			2.30	5.86
Day 3		8.16	2.68	7.50
Day 4			6.90	6.24
Day 5		41.40	10.34	7.24
Day 6	77.73 (10th day)		17.62	7.47
Day 7		53.35	21.84	7.70
Day 8			34.48	7.79
Day 9		55.39	44.44	7.84
Day 10			47.51	7.57
Day 11	-	64.87	52.49	7.75
Day 12	-		56.32	7.40

Table 4.5 The comparative study of the Potential Difference across different electrodes

Days	Graphite lead	Carbon	Aluminium mesh	Copper
	Potential Difference in milli volts			
0	174	186	135	169
1	175	247	147.5	172
2	179	728	151	180.8
3	238	733	157	188.7
4	240	752	133	197.3
5	243	787	163	202.5
6	270	893	167.5	210.6
7	536	1016	170.5	215.6
8	566	1270	187	218.5
9	696	1272	200.4	222.8
10	709	1514	210.4	225.50
11	712	1541	216.5	230
12	722	1544	236	237

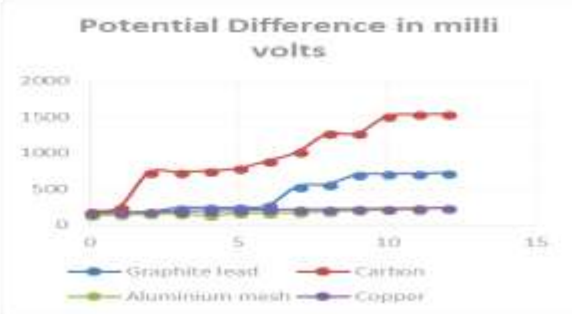


Fig.6 The comparative study of the Potential Difference across different electrodes

5. Validation of results by Regression analysis.

Regressional analysis can be used by using excel to determine the predictive results. powerful tools by which the designers of waste treatment systems can find the performance of a number of potentials under a variety of conditions. of this part of thesis work is to use regressional analysis for domestic wastewater treatment to compare results. [6]

For Graphite lead- followings graph and tables.

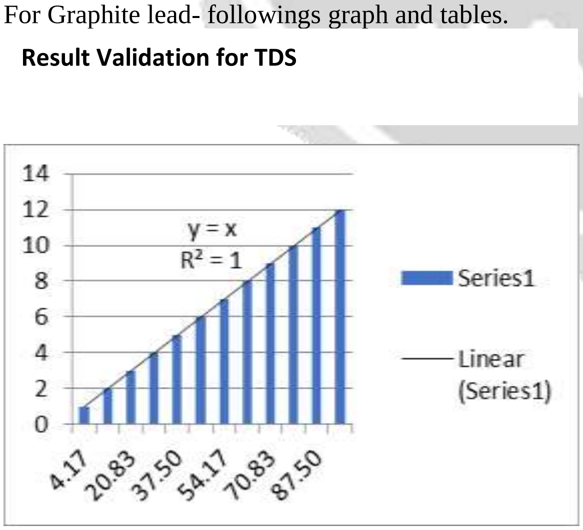


Fig. 7 Results Validation for TDS

Table 5.13 b) Result Validation for TDS

DAYS	BY REGRESSIONAL ANALYSIS	BY EXPERIMENTAL RESULTS
1	4.17	00
2	12.50	2.59
3	20.83	4.81
4	29.17	10.00
5	37.50	13.33
6	45.83	20.37
7	54.17	23.33
8	62.50	33.70
9	70.83	38.15
10	79.17	39.63
11	87.50	40.74
12	95.83	42.96

As per the above result regressional analysis and experimental analysis percentagae varying from first day to last day obsearvation.at last day regressional; analysis gives 95.83 % predictable and By experimental analysis 42.96%TDS removal.by developing microbial culture we can increase results as per prediction.

6. CONCLUSIONS

MFCs are a promising technology for the production of electricity from organic material and wastes.

Double chambered MFC were run parallel. The MFCs were operated by feeding domestic wastewater sample.graphite lead electrode and carbon electrode are efficient than aluminium and copper electrode. The effect of wastewater concentration on COD (64.87%), BOD (77.73%), TDS (56.32%), removal efficiency and current generation (1544 mV) by Carbon electrode.

7. REFERENCES

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