

Design of BFS in up flow Mode Using Synthetic Waste Water for the Optimization of Microorganisms

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ABSTRACT: Energy is the main requirement of this area. We as a developing country depend on energy for a various purpose. Recently, many nations put forth their initiatives on reducing the usages of polluting fossil fuels. It is well known that as a developing country for us. So alternative fossil fuels we are in need of non-polluting biological means of energy. Our another problems is waste materials produced on various productions in order to couple these two problems researches found technology that uses microbial community to degrade organic compounds in waste water and to create energy. In this current work we have decided to design a biochemical fuel system in up flow mode using synthetic waste water which resembles distillery waste water. The costs of membrane used in previous works are eliminated in the design and provisions have been for various electrode distances.

KEYWORDS : Microbial Fuel Cell (MFC), Biochemical Fuel System (BFS), Proton Exchange Membrane (PEM), Biochemical Oxygen Demand (BOD), Up flow Microbial Fuel Cell (UMFC), Hydraulic Retention Time (HRT), Mixed Liquor Volatile Suspended Solids (MLVSS), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Power output normalized to Anode (P_{an}), Power output normalized to Cathode (P_{cat}).

I. INTRODUCTION

The use of fossil fuels, especially oil and gas, in recent years has accelerated and this triggers a global energy crisis. Renewable bio energy is viewed as one of the ways to alleviate the current global warming crisis. Major efforts are devoted to developing alternative electricity production methods. New electricity production from renewable resources without a net carbon dioxide emission is much desired.

High energy requirement of conventional sewage treatment systems are demanding for the alternative treatment technology, which will be cost effective and require less energy for its efficient operation. In addition, due to global environmental concerns and energy insecurity, there is emergent interest to find out sustainable and clean energy source with minimal or zero use of hydrocarbons. Bacteria can be used in fuel cell to catalyze the conversion of organic matter, present in the waste water, into electricity Microbial fuel cells (MFC), if used for wastewater treatment, can provide clean energy for people, apart from effective treatment of wastewater. The benefits of using MFC for wastewater treatment include: clean, safe, quiet performance, low emissions, high efficiency, and direct electricity recovery. Traditionally, MFC consists of two chambers, anode and cathode, separated by proton exchange membrane (PEM). Microorganisms oxidize the substrate and produce electrons and protons in the anode chamber. Electrons, collected on the anode, are transported to cathode by external circuit and protons are transferred through the membrane internally. Thus, potential difference is produced between anode chamber and cathode chamber due to dissimilar liquid solutions. Electrons and protons are consumed in the cathode chamber by reducing oxygen, usually from water. Most of the bacterial species used in fuel cells are known to be inactive for transport of electrons. Hence, for intervention

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synthetic and natural compounds, called redox mediators, are used, such as, neutral red, methylene blue, thionine, and humic acid. With addition of such mediators, commercial application of MFC for wastewater treatment becomes difficult, because most of these mediators are expensive and toxic in nature. Hence, today it is emphasized to develop mediator-less MFC, by enhancing its power production and reduction of its operational cost, to increase its acceptance as wastewater treatment process.

Table 1: Basic components of microbial fuel cells

| Items | Materials | Remarks |
|------------------------|--|-----------|
| Anode | Graphite, graphite felt, carbon paper, carbon-cloth | Necessary |
| Cathode | Graphite, graphite felt, carbon paper, carbon-cloth, black, | Necessary |
| Anodic chamber | Glass | Necessary |
| Cathodic chamber | Glass | Necessary |
| Proton exchange system | Ultrex, polyethylene. poly (styrene-co-divinylbenzene); salt bridge, porcelain septum, or solely electrolyte | Necessary |
| ElectrodeCatalyst | Pt, Pt black, MnO ₂ , Fe ³⁺ , polyaniline, electron mediator immobilized on anode | Optional |

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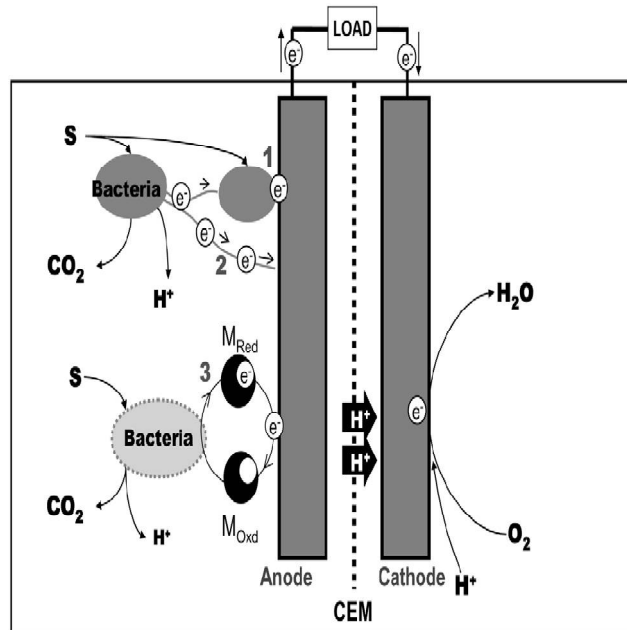


Fig 1: Conceptual diagram of a microbial fuel cell.

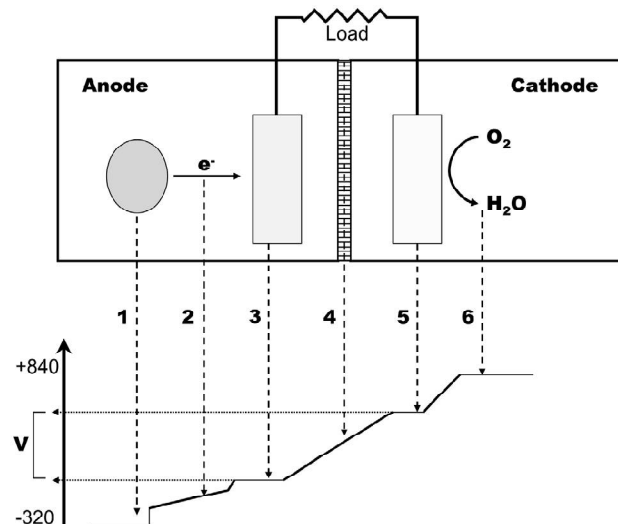


Fig 2: Various potential losses during electron transfer in a MFC.

- 1) Losses due to bacterial electron transfer.
- 2) Losses due to electrolyte resistance.
- 3) Losses at the anode.
- 4) Losses at the MFC resistance (useful potential difference) and membrane resistance losses.
- 5) Losses at the cathode.
- 6) Losses due to electron acceptor reduction.

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II. AIM AND OBJECTIVES

The aim of this project is to develop a simple, cheaper, energy efficient MFS for the treatment of distillery wastewater which has more solids and to recover electricity and hydrogen fuel out of this process. At the end of laboratory scale studies it is planned to scale up the process for a pilot plant scale. So only the applicability of this process and their associated problems will be resolved. In short our aim is using the energy coming out of this process for operating other important facilities in treatment plant.

- (i) Removal of undigested organic matter using microbes.
- (ii) Production of electricity, fuels and chemicals in the waste water.
- (iii) Traditional Method requires more electrical energy to digest the dissolved matter.

It is the only technology that has proven capable of extracting this energy from wastewaters on a commercial scale.

III. NEED FOR THE STUDY

The world is facing serious energy crisis in this era. We need energy for all our needs to be satisfied. We cannot imagine a world without electricity, a convenient form of energy. But energy cannot be derived easily. Energy nor be created not be destroyed. Some amount of energy has to be given for an equal conversion of energy to a convenient form. Or some mass to be converted to energy by piping out energy from it. But there are many problems in piping out energy from materials.

We can connect this energy problem to other important problem of developing countries. That is pollution. Out of pollution we are getting many materials as waste. Technically they are not waste because enormous amount of energy is hiding in those materials. If a technology which taps out energy from waste materials can solve both problems. One of the promising technologies is microbial fuel systems in which microbes are being used to degrade the waste materials and energy is tapped out of this process and that too in convenient form, electricity. In addition to that we can recover hydrogen fuel from this process. It is advantageous over anaerobic digestion of all kinds, because the end product of which is biogas is mostly used for the production of electricity. In that conversion we may expect some losses. But by using Microbial Fuel System the problem can be eliminated.

There are some problems yet to be addressed in Microbial Fuel System, such as membranes and mediators. Because of their cost it is hard to scale it up for an industrial level. So in this work it is planning to operate Microbial Fuel System without mediator and membrane less manner. Microorganisms which are responsible for degradation will be optimized for their environmental conditions and genera. Hydrogen is not a stable gas so some procedures have to be developed for the recovery of hydrogen fuel.

MFCs In The Future

The MFC technology has to compete with the mature methanogenic anaerobic digestion technology that has seen wide commercial applications because they can utilize the same biomass in many cases for energy productions. MFCs are capable of converting biomass at temperatures below 20°C and with low substrate concentrations, both of which are problematic for methanogenic digesters. A major disadvantage of MFCs is their reliance on biofilms for mediator-less electron transport, while anaerobic digesters such as up-flow anaerobic sludge blanket reactors eliminate this need by efficiently reusing the microbial consortium without cell immobilization. It is likely that the MFC technology will co-exist with the methanogenic anaerobic digestion technology in the future. To improve the power density output, new anodophilic microbes that vastly improve the electron transport rate from the biofilm covering an anode to the anode are much needed. Lovley claimed that an MFC's current flow could increase by four orders of magnitude if *Geobacter* transports electrons to the anode at the same rate as it does to its natural electron acceptor that is ferric iron. Mutagenesis and even recombinant DNA technology can conceivably be used in the future to obtain some "super bugs" for MFCs. Microbes may be used as a pure culture or a mixed culture forming a synergistic microbial consortium to offer better performance. One type of bacterium in a consortium may provide electron mediators that are used by another type of bacterium to transport electrons more efficiently to an anode. It is possible in the future that an optimized microbial consortium can be obtained to operate an MFC without extraneous mediators or biofilms while achieving superior mass transfer and electron transfer rates.

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ARTIFICIAL WASTE WATER

The artificial waste water was prepared by the following steps

Table: 2 Composition of synthetic wastewater

| Component | Sucrose | NaHCO ₃ | NH Cl | K ₂ HPO ₄ | KH ₂ PO ₄ | CaCl ₂ .2H ₂ O | MgSO ₄ .7H ₂ O |
|-----------|---------|--------------------|-------|---------------------------------|---------------------------------|--------------------------------------|--------------------------------------|
| mg /L | 300 | 480 | 9 | 10. | 5.2 | 63 | 19 |
| | - | | 5 | 5 | | | |
| | 450 | | | | | | |

IV. REACTOR DESIGN

Reactor volume and dimensions:

To determine the required reactor volume and dimensions, the organic loading, superficial velocity, and effective treatment volume must all be considered. The effective treatment volume is that volume occupied by the sludge blanket and active biomass. An additional volume exists between the effective volume and the gas collection unit where some additional solids separation occurs and the biomass is dilute. The nominal liquid volume of the reactor based on using an acceptable organic loading is given by

$$V_n = QS_0 / L_{org}$$

Where V_n = nominal (effective) liquid volume of reactor, m³

Q = influent flowrate, m³/h

S_0 = Influent COD, kg COD/m³

L_{org} = organic loading rate, kg COD/m³.d

To determine the total liquid volume below the gas collectors, an effectiveness factor is used, which is the fraction occupied by the sludge blanket. Taking into account the effectiveness factor, which may vary from 0.8 to 0.9, the required total liquid volume of the reactor exclusive of the gas storage area is given by

$$V_L = V_n / E$$

Where V_L = Total liquid volume of reactor, m³

V_n = nominal liquid volume of reactor, m³

E = effectiveness factor, unitless

Rearranging eq., the area of the reactor is

$$A = Q/v$$

The liquid height of the reactor is determined using the following relationship:

$$H_L = V_L / A$$

Where H_L = Reactor height based on liquid volume, m

V_L = total liquid reactor volume, m³

A = cross-sectional area, m²

The gas collection volume is in addition to the reactor volume and adds an additional height of 2.5 to 3m. Thus, the total height of the reactor is

$$H_T = H_L + H_G$$

Where H_T = Total reactor height, m

H_L = reactor height based on liquid volume, m

H_G = reactor height to accommodate gas collection and storage, m

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IV. REACTOR ANALYSIS

In the operation of mediator-less MFC several factors are considered as limiting steps for electricity generation, such as, fuel oxidation at the anode, presence of electrochemically.Active redox enzymes for efficient electrons transfer to the anode, external resistance of the circuit, proton transfer through the membrane to the cathode, and oxygen reduction at the cathode.A membrane-less microbial fuel cell (ML–MFC) which converted organic contaminants.From artificial wastewater to electricity. Such membraneless microbial fuel cell can improve the economic feasibility and acceptability.

Table 3: Characteristics of synthetic wastewater

| S.NO | PARAMETERS | VALUE |
|------|-----------------------------------|-------|
| 1. | p ^H | 4.2 |
| 2. | Total solids(mg/l) | 96400 |
| 3. | Total suspended solids(mg/l) | 4200 |
| 4. | Total dissolved solids(mg/l) | 38200 |
| 5. | Total volatile solids(mg/l) | 54000 |
| 6. | COD(mg/l) | 57000 |
| 7. | BOD(mg/l) | 32300 |
| 8. | Acidity CaCO ₃ (mg/l) | 11000 |
| 9. | Temperature (°C) | 34 |
| 10. | Total hardness (mg/l) | 2428 |
| 11. | Electrical conductivity (µmho/cm) | 16450 |
| 12. | Alkalinity (mg/l) | 2865 |

Electricity Production Based On Geobacter Sulfurreducens

Table 4: Values of electricity production in geobacter sulfurreducens

| S. No. | Hours | Current in µA | P max (mW/m ²) | P vol (mW/m ³) |
|--------|-------|---------------|----------------------------|----------------------------|
| 1 | 0 | 0 | 0 | 0 |
| 2 | 10 | 0 | 0 | 0 |
| 3 | 20 | 0 | 0 | 0 |
| 4 | 30 | 0 | 0 | 0 |
| 5 | 35 | 0 | 0 | 0 |
| 6 | 40 | 0 | 0 | 0 |
| 7 | 45 | 0 | 0 | 0 |
| 8 | 49 | 0.10 | 0.242 | 0.480 |
| 9 | 50 | 0.18 | 0.780 | 1.550 |
| 10 | 51 | 0.20 | 0.950 | 1.920 |
| 11 | 52 | 0.20 | 0.950 | 1.920 |
| 12 | 53 | 0.22 | 1.161 | 2.323 |
| 13 | 54 | 0.24 | 1.380 | 2.765 |
| 14 | 72 | 0.34 | 2.772 | 5.549 |
| 15 | 74 | 0.34 | 2.942 | 5.880 |
| 16 | 75 | 0.35 | 2.942 | 5.880 |
| 17 | 76 | 0.36 | 3.110 | 6.221 |

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|----|-----|-------|-----------|-----------|
| 18 | 77 | 0.36 | 3.110 | 6.221 |
| 19 | 78 | 0.36 | 3.110 | 6.221 |
| 20 | 97 | 0.41 | 4.034 | 8.069 |
| 21 | 98 | 0.42 | 4.233 | 8.457 |
| 22 | 99 | 0.43 | 4.438 | 8.875 |
| 23 | 100 | 0.44 | 4.646 | 9.293 |
| 24 | 101 | 0.46 | 5.078 | 10.157 |
| 25 | 102 | 0.47 | 5.032 | 10.603 |
| 26 | 121 | 0.71 | 12.098 | 24.197 |
| 27 | 122 | 0.72 | 12.442 | 24.883 |
| 28 | 123 | 0.73 | 12.790 | 25.597 |
| 29 | 124 | 0.74 | 13.142 | 26.285 |
| 30 | 125 | 0.85 | 21.528 | 65.884 |
| 31 | 126 | 0.90 | 28.637 | 77.120 |
| 32 | 145 | 1.40 | 47.040 | 94.080 |
| 33 | 146 | 1.50 | 54.000 | 108.000 |
| 34 | 147 | 1.50 | 54.000 | 108.000 |
| 35 | 148 | 1.70 | 69.360 | 138.545 |
| 36 | 169 | 1.90 | 86.640 | 173.774 |
| 37 | 170 | 2.00 | 96.000 | 192.476 |
| 38 | 171 | 6.00 | 864.212 | 250.685 |
| 39 | 172 | 6.10 | 893.221 | 279.640 |
| 40 | 173 | 6.20 | 922.146 | 380.988 |
| 41 | 192 | 6.40 | 983.565 | 1786.080 |
| 42 | 193 | 6.50 | 1040.120 | 1845.120 |
| 43 | 194 | 6.70 | 1077.236 | 1966.808 |
| 44 | 195 | 12.60 | 3810.000 | 2028.000 |
| 45 | 196 | 12.70 | 3870.125 | 2154.720 |
| 46 | 211 | 12.70 | 3932.214 | 7741.920 |
| 47 | 212 | 12.80 | 3993.658 | 7864.320 |
| 48 | 213 | 12.80 | 4704.321 | 7987.680 |
| 49 | 214 | 12.90 | 4771.512 | 9408.000 |
| 50 | 215 | 14.00 | 4839.120 | 9542.008 |
| 51 | 233 | 14.10 | 7975.124 | 15951.980 |
| 52 | 234 | 14.20 | 8028.587 | 16057.160 |
| 53 | 235 | 14.30 | 8046.954 | 16092.290 |
| 54 | 236 | 18.23 | 8072.554 | 16145.070 |
| 55 | 237 | 18.29 | 8081.973 | 16162.680 |
| 56 | 251 | 18.31 | 12962.870 | 25924.680 |
| 57 | 252 | 18.34 | 12973.685 | 25947.000 |

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| 58 | 253 | 18.35 | 13029.587 | 26058.720 |
| 59 | 254 | 18.65 | 13141.279 | 26282.880 |
| 60 | 255 | 23.24 | 13367.446 | 26734.080 |
| 61 | 256 | 23.25 | 13594.112 | 27189.120 |
| 62 | 268 | 23.30 | 14760.547 | 27878.120 |
| 63 | 269 | 23.40 | 14880.240 | 28110.235 |
| 64 | 270 | 23.60 | 14880.240 | 28110.235 |
| 65 | 271 | 23.80 | 14880.240 | 28110.235 |

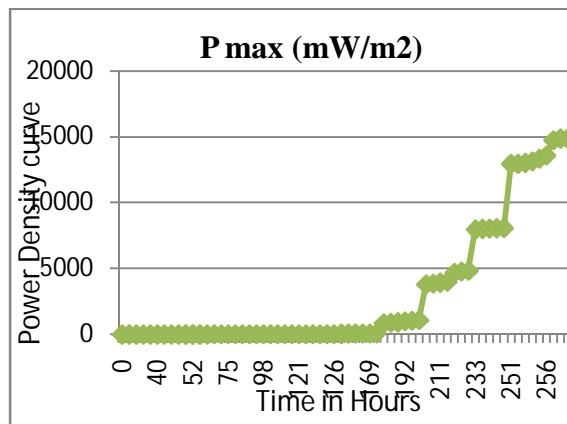


Figure: 3 Curves based on geobactersulfurreducens

Table 5: Values of electricity production in geobacter metallireducens

| S. No. | Hours | Current in μA | P max (mW/m^2) | P vol (mW/m^3) |
|--------|-------|--------------------------|----------------------------------|----------------------------------|
| 1. | 1 | 12 | 3456.0 | 6912.000 |
| 2. | 2 | 18.50 | 8214.365 | 1642.800 |
| 3. | 3 | 23.40 | 13141.325 | 26282.900 |
| 4. | 4 | 26.40 | 16727.695 | 33454.100 |
| 5. | 5 | 26.40 | 16727.000 | 33454.100 |
| 6. | 6 | 26.40 | 16727.000 | 33454.100 |
| 7. | 25 | 26.40 | 16727.000 | 33454.100 |
| 8. | 26 | 26.40 | 16727.000 | 33454.100 |
| 9. | 27 | 26.30 | 16727.000 | 33201.100 |
| 10. | 28 | 26.30 | 16600.00 | 33201.100 |
| 11. | 29 | 26.30 | 16600.00 | 33201.100 |
| 12. | 30 | 26.30 | 16600.00 | 33201.100 |
| 13. | 49 | 26.30 | 16600.00 | 33201.100 |
| 14. | 50 | 26.30 | 16600.00 | 32698.100 |
| 15. | 51 | 26.10 | 16349.021 | 32698.100 |
| 16. | 52 | 26.10 | 16349.021 | 32698.100 |
| 17. | 53 | 26.10 | 16349.021 | 32698.100 |
| 18. | 54 | 26.10 | 16349.021 | 32698.100 |
| 19. | 73 | 26.10 | 16349.021 | 32698.100 |
| 20. | 74 | 26.10 | 16349.021 | 32698.100 |
| 21. | 75 | 26.40 | 16727.000 | 33454.100 |

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|-----|-----|-------|-----------|-----------|
| 22. | 76 | 26.40 | 16727.000 | 33454.100 |
| 23. | 77 | 26.40 | 16727.000 | 33454.100 |
| 24. | 78 | 26.40 | 16727.000 | 33454.100 |
| 25. | 97 | 26.40 | 16727.000 | 33454.100 |
| 26. | 98 | 26.30 | 16600.000 | 33201.100 |
| 27. | 99 | 26.30 | 16600.000 | 33201.100 |
| 28. | 100 | 26.30 | 16600.000 | 33201.100 |
| 29. | 101 | 26.30 | 16600.000 | 33201.100 |
| 30. | 102 | 26.30 | 16600.000 | 33201.100 |
| 31. | 121 | 26.30 | 16600.000 | 33201.100 |
| 32. | 122 | 26.30 | 16600.000 | 33201.100 |
| 33. | 123 | 27.90 | 18681.000 | 37363.700 |
| 34. | 124 | 27.90 | 18681.000 | 37363.700 |
| 35. | 125 | 27.90 | 18681.000 | 37363.700 |
| 36. | 126 | 27.90 | 18681.000 | 37363.700 |
| 37. | 145 | 27.90 | 18681.000 | 37363.700 |
| 38. | 146 | 27.90 | 18681.000 | 37363.700 |
| 39. | 147 | 27.90 | 18681.000 | 37363.700 |
| 40. | 148 | 27.90 | 19357.400 | 37363.700 |
| 41. | 149 | 28.40 | 19357.400 | 38714.900 |
| 42. | 150 | 28.40 | 19357.400 | 38714.900 |
| 43. | 169 | 28.40 | 19357.400 | 38714.900 |
| 44. | 170 | 28.40 | 19357.400 | 38714.900 |
| 45. | 171 | 28.40 | 19357.400 | 38714.900 |
| 46. | 172 | 28.40 | 19357.400 | 38714.900 |
| 47. | 173 | 28.40 | 19357.400 | 38714.900 |
| 48. | 174 | 28.40 | 19357.400 | 38714.900 |
| 49. | 193 | 28.40 | 19357.400 | 38714.900 |
| 50. | 194 | 28.40 | 19357.400 | 38714.900 |
| 51. | 195 | 28.40 | 19357.400 | 38714.900 |
| 52. | 196 | 28.40 | 19357.400 | 38714.900 |
| 53. | 197 | 28.40 | 19357.400 | 38714.900 |
| 54. | 198 | 28.40 | 19357.400 | 38714.900 |
| 55. | 217 | 28.40 | 19357.400 | 38714.900 |
| 56. | 218 | 28.40 | 19357.400 | 38714.900 |
| 57. | 219 | 28.40 | 19357.400 | 38714.900 |
| 58. | 220 | 28.40 | 19357.400 | 38714.900 |
| 59. | 221 | 28.40 | 19357.400 | 38714.900 |
| 60. | 222 | 28.40 | 19357.400 | 38714.900 |

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|-----|-----|-------|-----------|-----------|
| 61. | 241 | 28.40 | 19357.400 | 38714.900 |
| 62. | 242 | 28.40 | 19357.400 | 38714.900 |
| 63. | 243 | 28.40 | 19357.400 | 38714.900 |
| 64. | 244 | 28.40 | 19357.400 | 38714.900 |
| 65. | 245 | 28.40 | 19357.400 | 38714.900 |
| 66. | 246 | 28.40 | 19357.400 | 38714.900 |
| 67. | 265 | 28.40 | 19357.400 | 38714.900 |
| 68. | 266 | 28.40 | 19357.400 | 38714.900 |
| 69. | 267 | 28.40 | 19357.400 | 38714.900 |
| 70. | 268 | 28.40 | 19357.400 | 38714.900 |
| 71. | 269 | 28.40 | 19357.400 | 38714.900 |
| 72. | 270 | 28.40 | 19357.400 | 38714.900 |
| 73. | 289 | 28.40 | 19357.400 | 38714.900 |
| 74. | 290 | 28.40 | 19357.400 | 38714.900 |
| 75. | 291 | 28.40 | 19357.400 | 38714.900 |
| 76. | 292 | 28.40 | 19357.400 | 38714.900 |
| 77. | 293 | 28.40 | 19357.400 | 38714.900 |
| 78. | 294 | 28.40 | 19357.400 | 38714.900 |
| 79. | 313 | 27.00 | 17496.000 | 34992.000 |
| 80. | 314 | 26.00 | 16224.000 | 32448.000 |
| 81. | 315 | 25.80 | 15975.004 | 31950.700 |
| 82. | 316 | 25.00 | 15000.000 | 30000.000 |
| 83. | 317 | 24.40 | 14288.660 | 28577.300 |
| 84. | 318 | 24.00 | 13824.000 | 27648.000 |

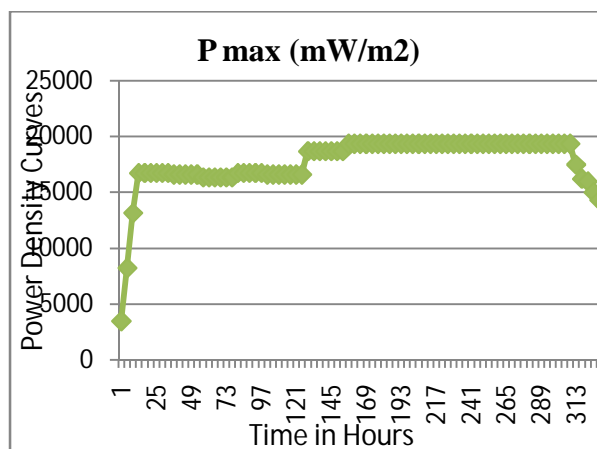


Figure: 4 Curves based on geobactermetalli reducens

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Two batches of study as shown in figure. Batch 1 produced the power very low as such cannot be shown in the graph. Log graph showing total current produced in all batches. Batch 1 is the lowest current producer. It can be explained as it's the first reaction batch. Initial sludge used is mostly inactive. This is the difference between aerated and unaerated. As of batch 2 aerated sludge volume, it was getting low sludge input result in low current production.

Performance Of The ML-Mfc For Cod Removal

The ML-MFC was operated at influent COD concentration in the range of 50000–60000mg/l. After completion aerated and unaerated treatment of operation, when steady state condition for COD removal reached, the COD and BOD reductions were 81% and 85%, respectively. The observed COD removal efficiency was on the higher side of the maximum reported efficiency in the range of 80–90%. Further studies are required to explore maximum volumetric loading rate capacity for this ML-MFC. The COD removal percentage in anode chamber was 47.2% and remaining COD was getting removed in the cathode chamber.

Lower COD removal efficiency observed in this case could be attributed to the mixed culture used as inoculums. Further investigation would be necessary to enhance the COD removal in anode compartment and, hence, to increase current production. However, the overall efficiencies observed for COD and BOD removal demonstrated the ability of ML-MFC as an effective wastewater treatment process.

Table 6: COD reduction

| S. No. | Wastewater Treatment | COD reduction |
|--------|--------------------------|---------------|
| 1 | Geobactersulfurreducens | 82% |
| 2 | Geobactermetallireducens | 76% |

Table 7 Columbic Efficiency

| S. No. | Total current produced | Columbic Efficiency |
|--------|--------------------------|---------------------|
| 1 | Geobactersulfurreducens | 50% |
| 2 | Geobactermetallireducens | 45% |

V. CONCLUSION

General

A membrane-less fuel cell-type electrochemical device was developed and used successfully to enrich electrochemically active microbes that converted organic contaminants to electricity. Since the wastewater flow through anaerobic as well as aerobic zone, proper operation of this device can achieve treatment of wastewater containing organic contaminants. Further studies would be necessary to optimize the electricity production from this ML-MFC. Efforts should be made to maximize the transport of electrons from the bulk to the electrode surface by identifying procedure for enrichment of anodophilic bacteria from the mixed anaerobic sludge to optimize electricity production. With further improvements and optimization, it could be possible to increase power generation. Thus, the combination of wastewater treatment along with electricity production might help in compensating the cost of wastewater treatment.

The membrane-less microbial fuel cell, inoculated with mixed anaerobic sludge demonstrated its effectiveness as a wastewater treatment process along with electricity production, without incorporating any costly component, such as mediator and membrane. The COD, BOD removal were achieved at varying levels. Granulation of biomass was

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observed in the anode compartment of the ML–MFC. Maximum power density was observed spacing between the electrodes and optimizing microorganisms. Further studies would be necessary to optimize the electricity production from this ML–MFC. With further improvements and optimization, it could be possible to increase power generation.

Also MFC as a continuous reactor can also be used. Going further toward the condition to be maintained in the reactor, aerated condition produces more electricity and it is instantaneous. In case of unaerated chamber, the current production is delayed by some time, due to inability of the reactor to complete the reaction in both chambers. 6-8 weeks of sludge is recommended for reaction. Thus, the combination of wastewater treatment along with electricity production might help in compensating the cost of wastewater treatment.

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BIOGRAPHY



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