Abstract

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Author's Profile :-

Kamatchi B[1], Sowmya Hari[1], Manjunathan Jagadeesan[2], SakthiselvanPunniavan[1]

[1]Department of Bioengineering, School of Engineering, VISTAS, Pallavaram, Chennai-600117

[2]Department of Biotechnology, School of Life Sciences, VISTAS, Chennai-600117.

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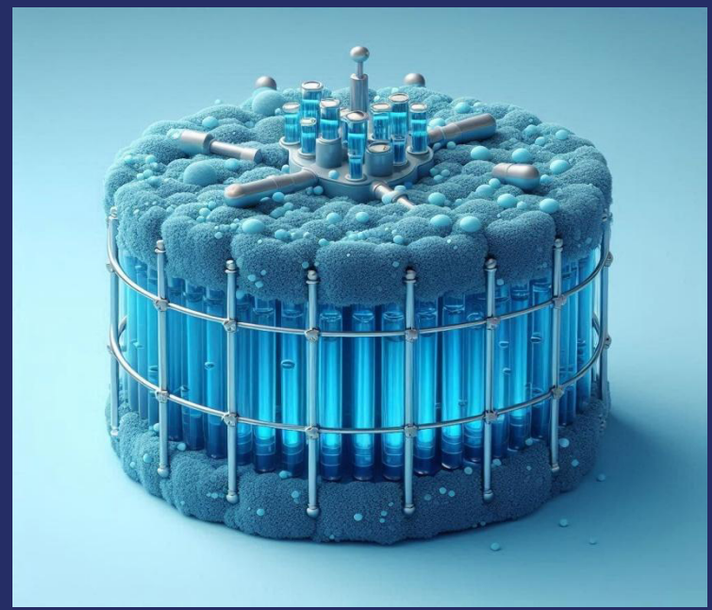

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by

Kamatchi B

Department of Bioengineering, School of Engineering, VISTAS, Pallavaram, Chennai-600117

Sowmya Hari

Department of Bioengineering, School of Engineering, VISTAS, Pallavaram, Chennai-600117

Manjunathan Jagadeesan

Department of Biotechnology, School of Life Sciences, VISTAS, Chennai-600117 .

Sakthiselvan Punniavan

Department of Bioengineering, School of Engineering, VISTAS, Pallavaram, Chennai-600117

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ABSTRACT:

Microbial fuel cell(MFC) has been consumed for the electricity production using a variety of waste sediments and water.MFC has the good output in generating electricity and water treatment,. The aim of the experiment is to perform electricity generation by using *sacchromycescerevisiae* as a biocatalyst in a double chamber linked using salt bridge. MFCs can be utilized to generate both bio-electricity and remediate wastewater. Experiments were conducted using wastewater from the textile industry. Effluents from Textile industries collected from different locations. The impact of cathodes on power generation and COD reduction on the process has been thoroughly investigated. In copper and pencil lead electrode, the greatest power density current density and certain sample analysis were observed.

Keyword:Microbial fuel cell, *sacchromycescerevisiae,* double chamber, salt bridge.

CHAPTER 1: INTRODUCTION:

The world's energy demands have enlarged in recent years, which cause global energy crisis. Microbial fuel cells (MFCs) are a type of technology that converts the energy held in chemical bonds in organic compounds into electrical energy via catalytic reactions involving microorganisms. MFCs use microorganisms as biocatalysts to oxidise organic materials and transmit electrons to the anodic surface for bioelectricity production via substrate oxidation (Du et al., 2007; Logan, 2009; Wang et al., 2015a). A wide range of organic starch, cellulose, carbohydrates, organic acids, and other substances. Toxic waste compounds such as phenol, proteins/amino acids, and chitinindole, ethanolamine, p-nitrophenol, nitrobenzene, polycyclic aromatic hydrocarbons (Xia et al., 2015) have employed oxidizable substrates to power MFCs. Municipal water, paper mill, food industry, and metal industry wastewaters, polluted wastewater, swine wastewater, brewery/distillery waste, and marine waste are all illustration of waste. Sediments have also proven to be effective. Sediments have also been used to generate bioelectricity in laboratory MFC devices and biomaterials production (Zhou et al., 2013b). This discovery ushered in MFC research and subsequent technical advancements. MFC research progressed slowly at first due to a slide of unpredicted practical obstacle. Redox-active mediators were commonly utilised in MFCs to boost power performance until the 1980s. These electron-donating mediators sped up the rate of electron transfer from the microorganisms to the anode, considerably increasing the current and power density output of MFCs. MFCs have been widely employed in laboratory wastewater treatment studies, yielding some extremely promising findings (Gude, 2016; Zhang et al., 2016). As a result, using wastewater as a substrate in MFCs to produce bioelectricity is seen as "environmentally benign. "Wastewater from the textile industry is heavily polluted. Therefore, textile wastewater requires the most sophisticated and expensive treatment method. In my project, I am developing a new technology for removing pollutants and generating electricity from wastewater from the textile industry using a single chamber microbial fuel cell. Textile wastewater is one of the most complicated wastewaters to treat because of the complex pollutants that it is composed of. That contains high concentration of colour, COD, suspended solids and others pollutants. Because it is a complex type, Textile wastewater requires most sophisticated and thus expensive treatment methods which are not affordable to Textile industries in developing worlds (Dr. Sashikant. R. et al 2016). Physical, chemical and biological methods are used to treat Textile wastewater. Some of them are effective treatments but some are not that efficient. Some of the methods such as reverse

osmosis, nano-filtration and ultrafiltration, are very expensive and many developing countries cannot afford the cost of installation and operation. Therefore, a new type of treatment technology, which would be effective in pollutant removal and affordability, is inevitable for growing industry mechanical wastewater is exceedingly contaminated. So, Textile wastewater requires most advanced and costly methods. Microbial fuel cell (MFC) era is the brand-new technique for generating power from biomaterial through the use of microorganisms. MFCs convert the chemical strength saved in natural fabric to cutting-edge strength through microorganisms which act as biocatalysts in anaerobic condition. Therefore, MFC are additionally referred to as electrochemical converters. Microorganisms in the anode chamber oxidize the substrate delivered to the device inclusive of Textile wastewater and bring electrons and protons. Industrial textile wastewater is an important organic source for power generation using MFC. This project demonstrates using double-chamber MFC-technology to treat textile waste water and generate directly from textile wastewater.

Previously experiments were done using only few microorganisms to turn out electrical energy. Potentially most of the organisms were used as biocatalysts to generate electricity and further applications. In the past, it was thought that only microorganisms could be used to generate electricity. Nowadays, most microorganisms have the potential to be used as biocatalysts for MFC. The earliest concepts of MFC were *Escherichiacoli* and *Saccharomyces* sp by Potter (Ieropoulos et al., 2005a) in 1910. Live cultures was used to generate electricity at the platinum electrode (Potter, 1912). However, little attention was paid until the early 1980s when the used electronic mediators to improve the production of electricity many times, furthering this concept. MFC Advantageous for wastewater treatment compared to conventional technology Improvement of conversion efficiency and Solid waste (Park Y et al.,2017). It can also be used for low intensity treatment Wastewater unsuitable for anaerobic digestion of In addition, it can operate at ambient temperature. Types of MFC's, electrode variation sample analysis were briefly explained.

i)MICROBIAL FUEL CELL (MFC):

Microbial fuel cells (MFCs) are electrochemical devices that utilize the metabolic activity of microorganisms to oxidize fuels and generate electricity either directly to electrodes or by transfer of intermediary electrons. Devices Consists of anode chamber, cathode chamber, electrodes, and proton exchange membrane and an external circuit. MFC converts biodegradable substrates directly into electricity (B.E.Logan et al.,2008). The anode

keeps microorganisms and organic matter in an anaerobic environment. The cathode contains conductive saline in the air for dual chamber MFC or single chamber. Microorganisms produce protons and electrons, and the organic substrate is converted into energy. This energy is used and stored by microorganisms for growth. The electrons are transferred directly to the anode electrode and cathode electrode via copper wire or conductive material. Protons pass through the ion exchange membrane and reach the cathode chamber, producing water as a result of the reduction process.

ii)MECHANISM:

Microorganisms in MFCs oxidise organic matter to produce electrons, which are then passed through a series of respiratory enzymes in the cell to produce energy in the form of ATP. After that, the electrons are liberated and reduced in a terminal electron acceptor (TEA). Many TEAs, such as oxygen, sulphate, and nitrate, readily diffuse into cells, where they absorb electrons and generate products that can then diffuse out. (Kim, J Sayed et al.,2017; et al.,2008)

TYPES OF MFC:

- Double-Chamber MFC
- Single-Chamber MFC (SCMFC)
- Stacked MFC
- Upflow MFC

Double-Chamber MFC:

The simplest MFC design is the double-chamber MFC. In a common design, one bottle serves as an anode and the other as a cathode, with PEM separating them. A defined medium in the anode and a defined catholyte solution are often utilized to generate energy in two- chamber MFCs. (Kumar et al.,2017) .In a typical design, one bottle (can be of different designs) is used as anode while the other one as cathode, separated by PEM. Usually in two-chamber MFC, defined medium (or substrate) in the anode and defined catholyte solution is used to generate energy. It is a common and inexpensive design that consists of two bottles joined by a tube containing a separator, which is commonly a cation exchange membrane (CEM) or a anion exchange (AEM) Nafion or Ultrex, for example, or a simple salt bridge.

The quantity of power generated in these systems is influenced by the surface area of the cathode compared to the anode, as well as the surface of the membrane. (Logan et al,, 2006)

Single-Chamber MFC (SCMFC):

In this type of MFC, the anode and cathode are both housed in a single chamber. PEM separates the anode from the cathode, which is either far or near it. When compared to double chambered MFC. This MFC is a simple and co-effective double-chamber MFC that also produces a lot of electricity. (Kumar et al.,2017). In single compartment microbial fuel cells (SCMFC), the wastewater to be cleaned and the microbial catalysts are deposited in only one anode chamber. External wire transports electrical ions formed in the anode to the cathode. In SCMFCs, air is directly exposed to the cathode, allowing oxygen to be taken from the surrounding environment. (Jinisha et al., 2020).

Stacked MFC:

A stacked MFC is a collection of MFCs connected in series or parallel to increase power output. MFC unit cells can be connected in series or parallel, and the individual power outputs can be multiplied to get the total power output. (Sun et al.,2012) When separate MFCs are combined in series or parallel to form a stacked MFC, the final voltage may not be exactly the sum of the individual cell voltages due to voltage loss. The parallel linked stack MFCs produce more current than the competition MFCs when MFCs are stacked in a series connection. As a result, we may deduce that parallel connected stack MFCs create a faster rate of bio-electrochemical reaction than single stack MFCs. Also, in order to improve wastewater treatment efficiency, Parallel connections are recommended for increased chemical oxygen demand (COD) removal.

Upflow MFC:

A cylindershaped MFC is used for upflow. The cathode chamber is on top, while the anode is on the bottom, of the MFC. Glass wool and glass bead layers divide the chambers into two sections. The substrate is supplied from the anode`s bottom, goes upward to the cathode, and finally departs at the top. (Kumar et al.,2017) There are no separate anolyte and catholyte in his design. Moreover, there is no spatial separation. As a result, proton transfer the problem is very rare. (Venkata Mohan S et al., 2014)

iii)ANODE:

For better interaction between electroactive biofilms and material surfaces, The material used as the anode electrode must exhibit various unique properties such as electricity. Conductivity, biocompatibility, large surface area, excellent electrical, mechanical, Chemical stability. The material must also be environmentally friendly and chemically inert Anode (electrolyte) in the anode compartment. (Kumar et al., 2017)

MATERIALS:

The conventional carbon materials such as carbon cloth, carbon brush, carbon paper, carbon felt, carbon rod, carbon veil, granular graphite, granular activated carbon, plate, reticulated vitreous carbon and carbonized cardboard. The metal based materials like, stainless steel plate, stainless steel scrubber, stainless steel mesh, silver sheet, nickel sheet, copper sheet, gold sheet and titanium plate are generally used as the anode materials. (Santoro et al.,2017)

iv)CATHODE:

The cathode material affects the overall cell voltage and should have high redox potential. (Sayed et al.,2017). The cathode compartment contains the cathode material, a catalyst to increase the reduction of electrons and an electron acceptor. (Wang Y et al.,2014). Ferricyanide (K3 [Fe (CN)6]), on the other hand, is a very common electron acceptor that has been frequently employed in MFCs due to its good performance. Ferricyanide it is used as an electron acceptor for MFC, so no catalyst is required for the cathode. Due to this fact that there is a moderate overvoltage when used with a simple carbon electrode. (I'm hungry L et al., 2012)

v)ELECTRODE:

The efficiency of MFC depends on several factors, one of which is the electrode material. There are many designs and configurations of MFC that have been tested and developed in recent years to improve MFC performance and efficiency. Table 1 shows the types of electrodes used.

Table 1: Types of Electrodes

STRUCTURE	ELECTRODE
BRUSH	Stainless steel mesh, carbon brush
PLANE	Metal, carbon paper, plates
PACKED	Granular graphite

vi)PROTON EXCHANGE MEMBRANE:

The proton exchange membrane is a core component that significantly affects the electrochemical performance of the MFC. The PEM has a structure that allows only hydrogen ions or protons to pass through. "Hydrogen with a proton exchange membrane fuel cell (PEMFC) is currently being considered as a potential alternative energy technology for the next generation due to its high energy density and abundance of hydrogen due to the nature. Polymer electrolytes for proton exchange membranes are this Nafion ionomer that increases the three-dimensional zone of catalytic activity. As hydrogen ions pass through the membrane, they combine with electrons in the reduction process to form water and carbon dioxide, completing the cycle.

Proton exchange membrane can affect the system of MFC system Internal resistance and concentration polarization loss and they affect the output power of MFC. Nafion is the most Popular for its highly selective transparency proton. Despite researchers trying to find less Nafion is still an expensive and durable alternative best choice. However, side effects of other cations Transportation during MFC operation are also inevitable. With the country. In a batch collection system, for example Transport of cation species other than B. In this sense, Nafion as well as other PEMs used in the MFCs are not a necessarily proton specific membranes but actually cation specific membranes. The PEM surface area has a large impact on maximum power output if the power output is below a critical threshold. The MFC internal resistance decreases with the increase of PEM surface area over a relatively large range (Oh and Logan, 2006). Min et al. (2005a) compared the performance of a PEM and a salt bridge in an MFC inoculated with G. metalli reduces. If the fuel resembles urban sewage. Membranelles MFC is preferred when fouling and cost are involved Membranes are a problem in such applications. Table 2 lists the materials used for MFC.

Table 2: MATERIALS USED FOR MFC COMPONENTS:

COMPONENTS	MATERIALS USED
CATHODE	Graphite, graphite felt, carbon paper, carbon-cloth, Pt, Pt black
ANODE	Graphite, graphite felt, carbon paper, carbon-cloth, Pt, Pt black, RVC
CATHODE, ANODE CHAMBER	Glass, polycarbonate, Plexiglas
PROTON EXCHANGE MEMBRANE	Proton exchange membrane: Nafion, Ultrex, polyethylene. poly, (styrene-co-divinylbenzene); salt bridge, porcelain septum, or solely electrolyte

vii)MICROBES IN MICROBIAL FUEL CELL:

The microorganism acquires energy by transporting electrons from a reduced substrate with a low potential to an electron acceptor with a high potential.

YEAST AS A CATALYST:

Yeast is a compartmentalized eukaryote of cells and has a more complex structure of compared to prokaryotes. Yeast is considered an ideal biocatalyst for microbial fuel cell applications because most strains are non-pathogenic, can metabolize a wide range of substrates, are robust s, and are easy to handle. Yeast cells also have a thick (100-200 nm) cell wall composed of polysaccharides and proteins (Gal I, Schlesinger O et al.,2016). Yeast cytochrome is present in mitochondria and transmembrane protein. MFC is constructed with both the external and internal mediators.

Several yeast have been studied as biocatalysts in MFC with or without external mediator such as *Saccharomyces cerevisiae (S. cerevisiae), Candida melibiosica 2491 (C. melibiosica), Hansenulaanomala (H. anomala) ,Hansenula polymorpha (Hansenula polymorpha), Arxulaadeninivorans (A. adeninivorans) and Kluyveromycesmarxianus (K. marxianus*)

Sacchromyces cerevisiae:

Baker's yeast (*S. cerevisiae*) is a unicellular organism used in the bakery and beer manufacturing industry. *S. cerevisiae* is a simple eukaryote that acts as a model system for many eukaryotes, including human cells, to study basic cellular processes such as cell cycle, DNA replication, recombination, cell division, and metabolism. It is a nuclear cell.*S Cerevisiae* is considered an excellent biocatalyst for MFC due to its wide substrate of , simple and rapid mass culture, non-pathogenic , cheap and long shelf life in dry condition.(Ostergaard S et al.,2000)

viii)MEDIATED YEAST MFC:

Several studies have been conducted to improve electron transfer by adding external mediators. Candidate external mediators are electrochemically active, rapid donation of electrons on the electrode surface, biocompatibility with microorganisms, solubility and chemically stable in anolyte media, easy penetration into cell membranes and some requirements such as probes must be met. Positive redox potential is sufficient to provide rapid electron transfer from microorganisms to anode, but not too strong to avoid large potential loss. Mediators are involved in electron transfer between microorganisms and the surface of the anode. This redox is either naturally exerted by microorganisms (internal) or added externally (external). These mediators, whether internal or external, are involved in electron transfer from bulk microorganisms to the anode surface (Wilkinson S et al.,2006).

Several external mediators have been investigated in MFCs such as methylene blue (MB), methyl red, methanyl yellow, methyl orange, bromocresol purple, bromocresol green, romothymol blue, bromophenol blue, Congo red, cresol red, eriochrome black T, murexide, neutral red (NR), yeast extract, etc.

ix) MEDIATORLESS YEAST MFC:

Mediator MFC is an MFC that works without adding an external mediator. Sayed et al. is *S. cerevisiae* has studied the mechanism by which electrons are transferred to the surface of the anode via a solution or surface confinement species of mediator less MFC. *S cerevisiae* was cultivated outside MFC and seeded into a mediator less air cathode MFC using glucose as a substrate.

Although *S. cerevisiae* can be effectively used as a biocatalyst for MFC without a mediator, the output of was limited due to the slow electron transfer rate from the microorganism to the surface of the anode of . The performance of *S.cerevisiae*-based MFC can be improved by increasing the electron velocity from yeast cells to the anode surface by one or more of the following techniques (Christwardana M.,2017;225:175-182). Anode change, Immobilization of yeast cells on carbon nanotubes, Yeast surface presentation of dehydrogenase, Addition of exogenous mediators

x)TEXTILE WASTEWATER:

The textile industry is one of the most polluted industries in the world. Wastewater contains a large amount of dye used for dyeing material. Azo dyes make up 60-70% of the dyes produced worldwide. They contain NN Double bonds called azo bonds, and aromatic side chains. The terms of the amount and composition of dyes used and in large quantities. The fabric for dyeing is contained in the wastewater. Dyes commonly used in the textile industry It is composed of groups of atoms based on different functional groups, so-called chromophores, Azo, nitro, carbonyl, etc

MICROBIAL FUEL CELL IN TEXTILE WASTE WATER:

Microbial fuel cells (MFCs) in textile water have the advantage of not requiring ventilation, anaerobic at the microbial level, with lower sludge yield than conventional one sprocess. Power generation from MFCs is relatively clean as it does not require a downstream refining process as in the case of methane and hydrogen production. Anaerobic digestion (Veera Gnaneswar Gude et al.,2016). Logan (Bruce E. Logan et al.,2005) proposed the use of MFC in wastewater treatment In contrast, recovering net energy from organic compounds during treatment.

APPLICATIONS OF MFC:

MFCs are a versatile research technique that is applied in a variety of fields. It is capable of pollutant degradation, bioelectricity generation, and the manufacture of value-added goods for future use. Here are some of the most important MFC applications.

- Electricity production
- Biohydrogen production Microbial fuel cells
- Biosensor

- Wastewater treatment
- Bioremediation
- Dye decolorization

CHAPTER-2: MATERIALS AND METHODS:

SAMPLE COLLECTION:

Waste water was collected from different areas of textile industry along with sludge.

FIGURE 1 TEXTILE WASTE SAMPLE

PREPARATION SALT BRIDGE:

A salt bridge was prepared by adding Agar and combination of salts was used such as sodium chloride (Nacl), potassium chloride (Kcl) and potassium nitrate (KNO3). 0,74g of hKcl, 0.5g of Nacl,1.04g of KNO3grams of salts is added in 100ml of distilled water in the beaker ,3.5grams of agar added along in the beaker. Mixed altogether and boiled for few minutes. The mixture is poured into the plastic tube which combine anode cathode chamber in which electrons pass through. Allowed to solidify in the tube and kept in the refrigerator.

FIGURE2- PREPARATION OF SALT BRIDGE

YEAST AS A BIOCATALYST:

Packet form of baker's yeast (*Saccharomyces cerevisiae*) was obtained from the local market and 5 grams of it was added to the test tubes containing the YEPD broth (yeast extract: 1 g peptone: 2 g and dextrose: 2 g) and incubated to proliferate and grow. This was used in MFC 1.

5 g of baker's yeast was weighed and dissolved in 100 ml of phosphate buffer (0.1 M) at pH of 7.8 followed by centrifuging it for 3000rpm for 3 minutes and finally incubating it. This was used in MFC 2, 3 respectively.

ELECTRODE PREPARATION:

Electrode (copper rod and pencil lead) was connected with copper wire which is wrapped in the fibre to control the charges passing electrons from the chamber. Immersed in the anode cathode chamber from the top lid and closed tightly.

ANODE CHAMBER (Anaerobic):

In the double chambered MFC construction, the anode chamber was a 1000ml glass bottle. Sample (textile effluent) is added in the anode chamber. Electrode was attached connected with the wire dipped into the sample. One side of salt bridge is attached using M-seal.

CATHODE CHAMBER

The cathode chamber of 1000ml, which is filled with 800ml water. The electrode is immersed in the water connected with wire. Another side of salt bridge is fixed using M-seal which makes them leak proof.

FIGURE 3 DOUBLE CHAMBER MFC

MFC CONSTRUCTION:

The experiment was carried out with the help of four 900ml containers and two chambered microbial fuel cells. Copper rods were fixed with wire as anode cathode in both the chamber. As a proton exchange membrane, an agar salt bridge was used. The anode chamber was filled with 800ml of effluent, while the cathode chamber was filled with 700ml of regular tap water. In each chamber, the appropriate electrode was fixed. The anode chamber was airtight to preserve anaerobic conditions. Copper wires were used to connect the electrodes to the multi-meter from the outside. The electrodes were not pre-treated in any way.

SAMPLE ANALYSIS:

The COD, BOD, pH, TSS, and TDS analysis of the effluent was done before the test and after the experiment

i) pH:

- The pH is one of the most significant effluent discharge quality parameters of an industry (Banerji,1993)
- pH was determined using portable pH meter.

FIGURE 4 pH value of the sample

ii)ELECTRICAL CONDUCTIVITY:

- The EC is indicating dissolved substances in an aqueous system. It depends on the dissociation of ions, their concentration, temperature, and migration in the electric field, but it does not give any idea about the type of ions present (Rump 1992).
- Electrical conductivity was measured with pH meter instrument itself.

FIGURE 5 ELECTRICAL CONDUCTIVITY OF THE SAMPLE

iii)Chemical oxygen demand (COD):

It shows the presence of all organic and inorganic matter content in the textile dyeing effluents. It comprises both the biodegradable and nonbiodegradable portions of live bacterial

attack, but it can be oxidized by strong chemical oxidants (Abbasi 1998; Tan et al. 2000; Chiron et al. 2000).

- A pinch of mercuric sulphate is added with sample of 20ml,10ml potassium dichromate,30ml conc.H_2S0_4 and a pinch of silver sulphate.
- Reflux it at 150 degrees Celsius for 2hrs in the COD digester.
- Cool the sample and titrate against 0.1N FAS with ferroin indicator.

$$\text{Formula} = \frac{(\text{Blank-sample}) \times \text{normality of FAS} \times 8 \times 1000}{\text{Volume of sample}}$$

$$\text{Formula} = \frac{(9.8-3.2) \times 0.1 \times 8000}{20}$$

FIGURE 6 COD DIGESTER

iv)BIOLOGICAL OXYGEN DEMAND (BOD):

It measures the amount of oxygen used by microorganisms in the biological process in water. BOD value is characterized in labat 27 degree Celsius for 3 days.

TSS and TDS were evaluated using filtration and evaporation which in kept in hot air oven (at 105o C).

Table 3: EFFLUENT CHARACTERIZATION BEFORE TREATMENT

SI NO	PROPERTY	VALUES
1	Ph	**6.8**
2	Electrical conductivity	**047 mv**
3	COD	**1192mg/l**
4	BOD at 27**°C** 3 days	**342mg/l**
5	TSS	**135mg/l**
6	TDS	**1464mg/l**

vi) Calculations:

The MFC was operated and the voltage was measured using the multi-meter. The Current was measured across an external resistance using the following formula].

- Voltage= current x resistance (I X R)
- Current=voltage/resistance(V/R)
- Power=voltage x current (V X I)
- Power density=power/surface area of the electrode
- Current density= current/surface area of the electrode
  (Surface area of the Copper electrode=0.01276m^2
  Surface area of the pencil lead electrode=0.004869$m^{2)}$

CHAPTER-3

RESULTS:

The MFC were observed for 10-15 days. The corresponding current and power density was calculated using the above-mentioned formulas. Graphs of MV vs days, current vs power density, resistance variance, highest value vs mv were drawn for each MFC configurations.

i) MFC SETUP- 1:

The highest power generated in the setup1 is 105.7mv using copper electrode,sample and yeast culture in the anode and tap water in the cathode without adding mediator in a anaerobic condition.

TABLE 4: ELECTRICAL PARAMETERS IN MFC-1

Mv	V	I(V/R)	P(V×I)	Power Density(W/m^2)	Current Density(A/m^2)
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
59.1	0.0591	5.91×10^{-6}	3.49×10^{-7}	0.000273	0.0000463
72.3	0.0723	7.23×10^{-6}	5.22×10^{-7}	0.000409	0.0000566
75.5	0.0755	7.55×10^{-6}	5.70×10^{-7}	0.000467	0.0000591
85.4	0.0854	8.54×10^{-6}	7.29×10^{-7}	0.000571	0.0000669
101.3	0.1013	1.013×10^{-6}	1.026×10^{-7}	0.000804	0.0000793
89.2	0.0892	8.92×10^{-6}	7.95×10^{-7}	0.000623	0.0000699
64.7	0.0647	6.47×10^{-6}	4.18×10^{-7}	0.000325	0.0000507

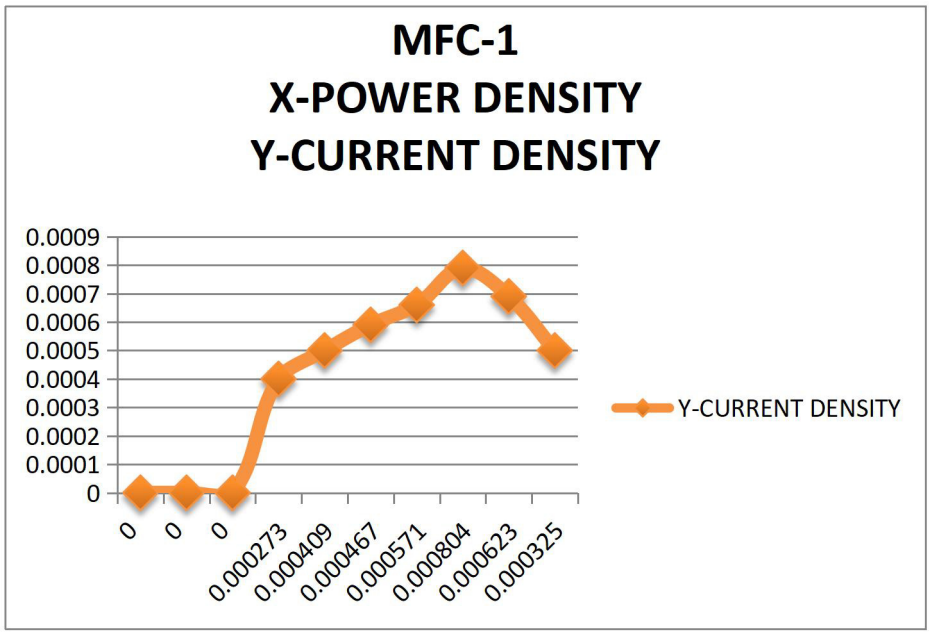

FIGURE 7GRAPH POWER DENSITY AND CURRENT DENSITY IN MFC-1

TABLE 5: POWER AND CURRENT DENSITY

Power Density(W/m^2)	Current Density(A/m^2)
0	0
0	0
0	0
0.000273	0.0000463
0.000409	0.0000566
0.000467	0.0000591
0.000571	0.0000669
0.000804	0.0000793
0.000623	0.0000699
0.000325	0.0000507

FIGURE 8 MFC-1 mv value

ii) MFC SETUP-2:

The highest power generated in the setup-2 is 138.2mv using copper electrode, sample and yeast culture in the anode and mineral buffer in the cathode by adding methylene blue of 10ml and glucose 10 g as substrate in a anaerobic condition.

TABLE 6 ELECTRICAL PARAMETERS IN MFC-2

mV	V	I	P	Power density(w/$m^{2)}$	current density(A/m2)
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
79.4	0.0794	7.94×10^{-5}	6.30×10^{-6}	0.0004937	0.00622
84.3	0.0843	8.43×10^{-5}	7.10×10^{-6}	0.000556	0.00660
96.5	0.0965	9.65×10^{-5}	9.31×10^{-6}	0.000729	0.00756
104.1	0.1041	1.041×10^{-4}	1.08×10^{-5}	0.000846	0.00815
111.5	0.1115	1.15×10^{-4}	1.28×10^{-5}	0.00103	0.009012
124.9	0.1249	1.249×10^{-4}	1.56×10^{-5}	0.00122	0.00978
131.2	0.1312	1.312×10^{-4}	1.80×10^{-5}	0.00141	0.01028
137.2	0.1372	1.372×10^{-4}	1.88×10^{-5}	0.00147	0.01075
134.9	0.1349	1.349×10^{-4}	1.819×10^{-5}	0.00142	0.01075
116.2	0.116.2	1.116×10^{-4}	1.35×10^{-5}	0.00105	0.00874
113.5	0.1135	1.135×10^{-4}	1.288×10^{-5}	0.00109	0.00889
105.7	0.1057	1.057×10^{-4}	1.117×10^{-5}	0.00875	0.00828

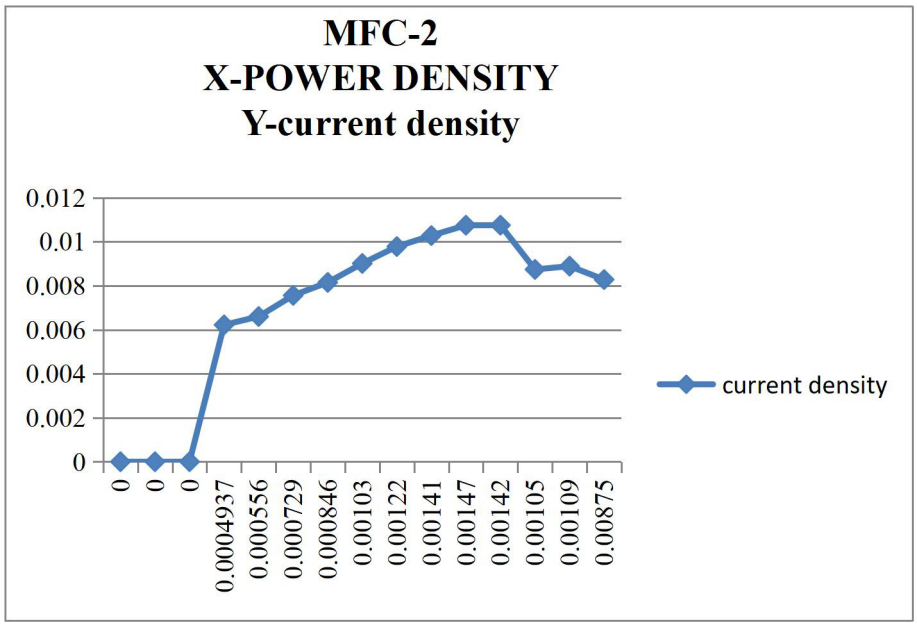

FIGURE 9GRAPH OF POWER AND CURRENT DENSITY IN MFC-2

iii)MFC SETUP-3:

The highest power generated in the setup-3 is 77.3mv using pencil lead as electrode, sample and yeast culture in the anode and tap water in the cathode by adding methylene blue of 5ml, potassium permanganate of 5ml and glucose 10g as mediator in a anaerobic condition.

TABLE 7 ELECTRICAL PARAMETERS IN MFC-3:

Mv	V	I	P	Power density($W/m^{2)}$	Current Density($A/m^{2)}$
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
33.5	0.0335	3.35×10^{-5}	1.122×10^{-6}	0.0002304	0.00688
49.3	0.0493	4.93×10^{-5}	2.43×10^{-6}	0.000499	0.010125
55.4	0.0554	5.54×10^{-5}	3.06×10^{-6}	0.000630	0.011378
60.3	0.0603	6.03×10^{-5}	3.63×10^{-6}	0.0007467	0.01238
75.7	0.0757	7.57×10^{-5}	5.73×10^{-6}	0.00117	0.01554

65.1	0.0651	6.51×10^{-5}	4.23×10^{-6}	0.000868	0.01337
37.3	0.0373	3.72×10^{-5}	1.39×10^{-6}	0.000285	0.00766
32.5	0.0325	3.25×10^{-5}	1.05×10^{-6}	0.000215	0.00667
20.9	0.0209	2.09×10^{-5}	4.36×10^{-7}	0.0000895	0.00429
17.6	0.0176	1.76×10^{-5}	3.09×10^{-7}	0.0000634	0.003614

FIGURE 10 MFC SETUP-3(COPPER ROD)

TABLE 8 CURRENT AND POWER DENSITY IN MFC-3

Power density($W/m^{2)}$	**Current density(A/m^2)**
0	0
0	0
0	0
0	0
0	0
0.0002304	0.00688
0.000499	0.010125
0.000630	0.011378
0.0007467	0.01238
0.00117	0.01554
0.000868	0.01337

0.000285	0.00766
0.000215	0.00667
0.0000895	0.00429
0.0000634	0.003614

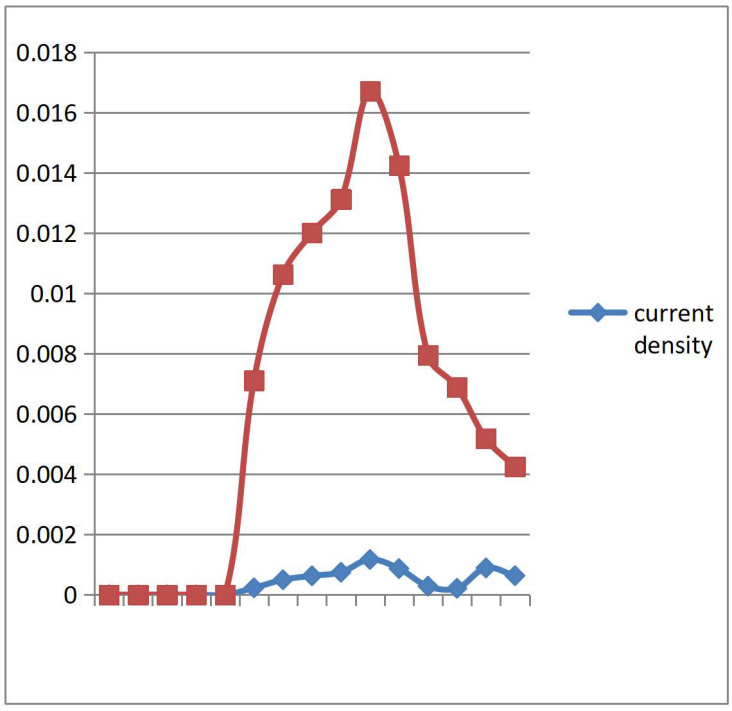

FIGURE 11GRAPH OF CURRENT AND POWER DENSITY IN MFC-3

FIGURE12 MFC -3 USING PENCIL LEAD

TABLE 9: OBSERVATION OF ALL MFC'S:

DAYS	MFC-1(mv)	MFC-2(mv)	MFC-3(mv)
1	0	0	0
2	0	0	0
3	0	0	0
4	63.4	80.3	0
5	79.3	85.9	0
6	82.5	97.2	34.2
7	91.3	105.2	50.9
8	105.7	113.1	56.8
9	93.2	126.1	61.6
10	70.7	132.9	77.3
11	0	138.2	65.9
12	0	136.4	38.9
13	0	117.7	33.4
14	0	114.1	21.5
15	0	106.9	18.1

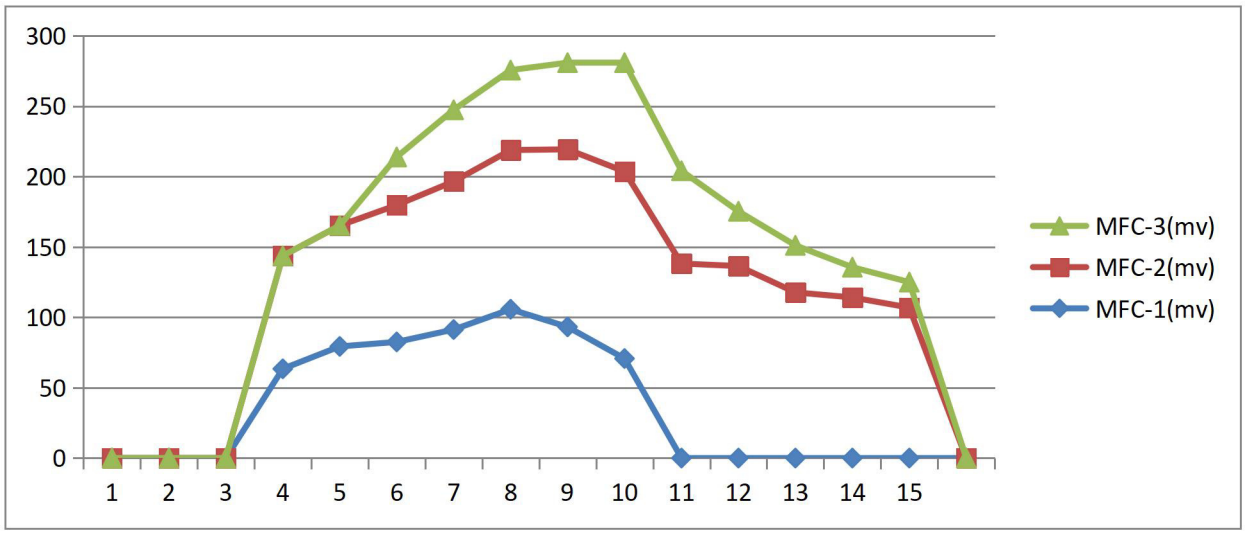

FIGURE 13 GRAPH OF OBSERVATION OF ALL MFC'S

TABLE 10 VARYING RESISTANCE WITH ALL MFC'S

Resistance variance(K)	MFC-1(mv)	MFC-2(mv)	MFC-3(mv)
10	18.1	18.8	21.1
9	18.9	20.6	22.7
8	20	21.5	24.0
7	23.2	23.7	25.3
6	25.1	24.3	27.8
5	26.4	26.2	28.6
4	29.9	28.4	29.2
3	30.3	29.4	30.3
2	35.4	30.8	32.8
1	38.9	32.6	33.4

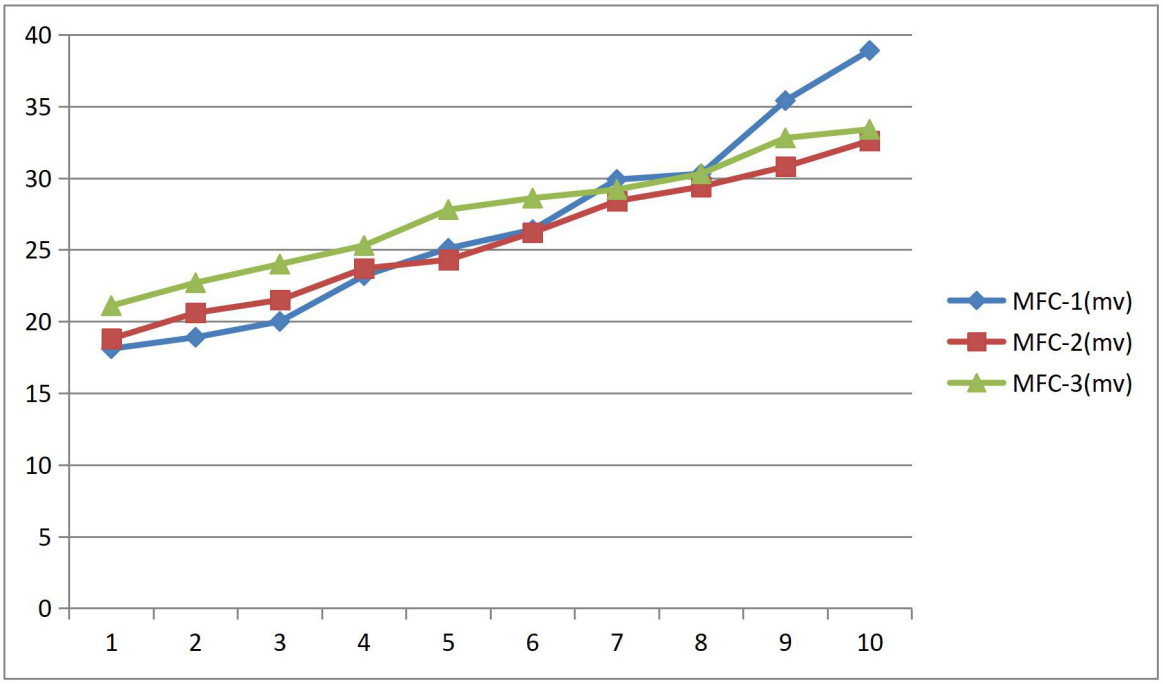

FIGURE 14 GRAPH OF VARYING RESISTANCE WITH ALL MFC'S

TABLE 11HIGHEST VALUE AND MFC'S

MFC's	Highest mV value
MFC-1	105.7
MFC-2	138.2
MFC-3	77.3

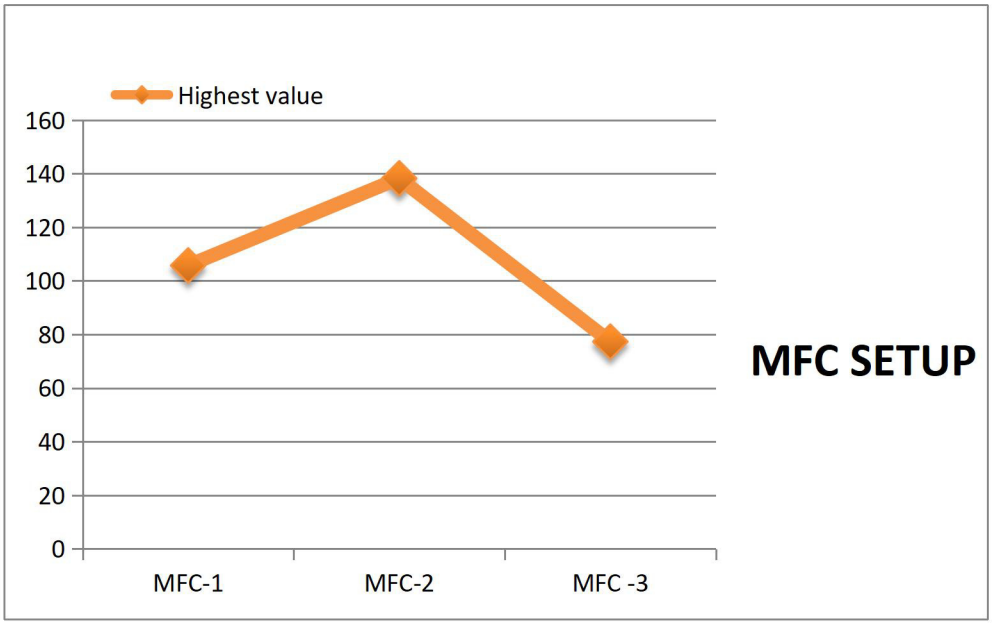

FIGURE 15 HIGHEST VALUE AND MFC'S

iv)PROPERTIES:

The output characteristics of the MFC setups differed due to the different properties of the electrode. The electrode voltage and electron accepting capacity of the electrodes vary, which causes the output to vary.

TABLE 11EFFULENT CHARACTERIZATION AFTER TREATMENT:

SI NO	PROPERTY	MFC-1	MFC-2	MFC-3
1	Ph	6.4	6.2	6.3
2	COD	264mg/l	272mg/l	270mg/l
3	TSS	187mg/l	157mg/l	162mg/l
4	TDS	2098mg/l	1975mg/l	2056mg/l

CHAPTER-4

CONCLUSION:

Textile wastewater has been used to test microbial fuel cells.Two distinct cathode materials were compared in terms of output.The current work has shown that using textile effluent as a fuel source for the MFC is a viable option. Though the power generated was minimal, it might be improved by utilizing an electron mediator in the anode chamber and a catalyst in the cathode chamber. By comparing MFC 1,2,3 constructed with copper electrode and pencil lead, with and without mediator copper rod was produced more potential electricity generation 138.2 mV and pencil lead produced 77.3mV. It has also been demonstrated that MFCs aid in the decrease of COD levels. The maximum power density and current density was obtained from copper rod is MFC1-0.0008004W/$m^2$and 0.000793A/m^2,MFC 2-0.00147W/m^2 and 0.01075A/m^2,MFC 3-0.00117W/m^2 and 0.01554 A/m^2. From this experiment it is observed that copper electrode has more potential to generate electricity which can help the environment to use while doing production in large volume as further process.

CHAPTER-5

FUTURE PERSPECTIVES:

Fungi-based MFCs are already widely employed, although various challenges have arisen throughout their processing, such as limited power output. Sekrecka-Belniak and Toczyowska-Mamiska (2018) are looking for a novel fungal strain that can produce electricity and also overcome the mediator used in FMFCs. More research should be done to better characterise the fungus participating in the degrading process, as well as nonmaterials and nanotechnology techniques that will be used in bioremediation and energy production (Fogel and Limson 2016, pp. 551-575). Fungi can also be employed as a biocathode in MFCs to improve power generation, therefore cathode research is necessary.

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