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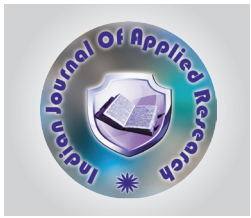

Studies on Construction, Standerdization And Working of Microbial Fuel Cells (Mfcs) For Bioenergy Production

KEYWORDS: microbial fuel cell; bioenergy; wastewater.

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ABSTRACT *Microbial fuel cell (MFC) is the bioelectrochemical device that utilize microorganisms as catalysts which convert chemical energy into electrical energy by providing a sustainable and eco-friendly source of bio-energy alternatively treating wastewater. A double chambered MFC has been constructed with salt bridge as a mean of proton transfer. The salt bridge is also helpful in separating the two chambers. The standardization of MFC designed was carried out by using synthetic wastewater before using the same MFC for sample analysis. The working of MFC was checked to analyze electrical potential using four different waste water samples namely Municipal sewage water, Agro waste water, Dairy waste water and Distillery waste water using four different sets. The maximum potential development was 700 mV, with mediator less MFC and potassium ferricynide as efficient catholyte with dairy waste water as substrate.*

Introduction
World is facing higher energy crises (Bond, D. R. and D. R. Lovely 2003). Demand for energy is continuously increasing. The conventional modes of electricity generation are on the way of loss. Not only that today's era is industrial era and energy input in terms of electricity to run industries much higher, conventional sources of electricity generation are fails to meet this demand of electricity for industries.

World become faster. This running life style demands high electricity to run routine domestic life. The industrialization, urbanization has created hazardous pollution problems. There is need of searching new modes of solution for pollution hazards. Each country having their own legal criteria for waste treatments. Thus every industry needs energy in terms of electrical power not only for production but also for waste treatment which is not economically affordable.

The conventional modes for electricity generation include water waves, wind power, combustion of fossil fuel etc. All these sources are getting scared and also the electricity generation using these sources causes global environmental problem that's why there is a need of new nature loving and sustainable mode of electricity generation and this need can be fulfilled successfully by bioelectricity generation (Bond, D. R. and D. R. Lovley 2003, Surjit Das and Neelam Mangwani, 2010). Bioenergy in terms of electricity using MFCs is the best alternative to conventional sources (M.M. Ghangrekar and V.B. Shinde 2009, Korneel Rabaey and Willy Verstraete 2005, Kim J. R., Min, B., Logan B. E.2004)

The current research try to find out a nature loving remedy for this problem and it deals with construction of MFCs and apply successfully it for electricity generation treating different industrial wastes.

MATERIAL AND METHODS
Designing and construction of microbial fuel cell unit:

The designing of microbial fuel cell was done according design in previous literature with certain modification. The microbial fuel cell was constructed using two Borosil glass bottles of 1 liter capacity one as anode chamber and another as cathode chamber (Animesh Deval and Anil Kumar Dikshit 2013). Both the bottles were with three holes, one at upper side for electrode, second at bottom of bottle as an outlet for effluent and third one at middle for the joining of two bottles and to serve a mean for salt bridge (A Muralidharan and K Ramasamy, 2012) for transfer of proton .The MFC was operated in batch wise manner. Four more MFCs were constructed using eight 1 liter plastic bottles (A.V. Pethkar et.al, 2012) else other material and procedures were similar as that of first one.

Other material used in construction of MFCs:
Electrodes: Two equal sized (11cm) carbon rods were used as anode and cathode.
Copper wire with plastic covering was used to connect anode and cathode.
A resistance of 1000 Ω was connected externally in series in between anode and cathode.
A digital multimeter, Haoyue DT830D was applied to measure the voltage in between two electrodes.
Salt bridge is constructed using 3 % agar and 3% NaCl (D'souza Rohan et.al, 2013). All the assembly is perfectly made leak proof by applying paraffin wax also to maintain anaerobic condition in anode chamber.
Phosphate buffer: Phosphate buffer of pH 7 were used in both chambers to keep the ionic balance.
L-Cystine used as oxygen scavenging agent in anode chamber.
Potassium ferricynide is used as electron acceptor in cathode chamber
Glucose is used as feed supplement in anode chamber to favor growth of microorganism
Substrate Synthetic waste water was primarily used as substrate in anode chamber to run MFCs. In second round three different Industrial waste water samples namely Agro waste water, Dairy waste water, Distillery waste water (Hampannavar U.S.2011), and a municipal waste water sample from nearby area of Osmanabad city (M.S.) were used as substrate in four different MFCs constructed during work.
Inoculum Laboratory isolated microorganisms from sewage

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sample were used as inoculum in anode chamber.
Standardization of MFC: (Animesh Deval and Anil Kumar Dikshit 2013).

Both the electrodes anode and cathode were soaked distilled water for 24 hrs prior to apply in MFCs. Firstly MFCs were operated using distilled water as anolyte as well as catholyte, MFCs are kept under watch for electricity generation.Then distild water in anode chamber was replaced with synthetic waste water as anolyte and catholyte was kept as it is that is distilled water. Cathode chamber was kept at aeration.In next step the anolyte was kept constant as synthetic waste water and potassium ferricynide was replaced as catholyte at the place of distil water.

The processing involves anode chamber with total working volume of 800 ml of which 500 ml was filled with substrate primarily the synthetic sewage and 220 ml phosphate buffer PH 7 the anaerobic condition was maintain by addition of L-cysteine 0.5 g /lit/ per batch. Along with synthetic sewage 5% glucose were added to favor growth of micro organism. The PH of anode chamber was maintained at 7 with 0.1N NaOH. Laboratory isolated microbial consortia in 10% quantity were used as inoculum for standardization of MFCs unit .The inoculum was enriched in nutrient broth for 48 hour prior to addition into MFCs chamber Cathode chamber also of 800 ml total working volume as that of anode chamber is feed with potassium ferricynide 5g in 500 ml distilled water plus 300 ml phosphate buffer of PH 7.The measurement of current was carried out in terms of voltage at every 24 hrs .The time duration of each batch was of 10 days .All the experiments were carried out in triplicate readings were taken and then after the second batch were loaded.

Before applying MFCs unit for second batch the first batch substrate was removed .The 10% of first batch substrate was kept as an inoculum for second batch .The substrate for second batch was 50% of synthetic sewage and 50% of waste water .The time duration of second batch also of 10 days all other procedures of current measurement were carried out as like first batch.

The third batch operation of MFCs were includes complete replacement of synthetic waste sample in anode chamber with different waste waters.

Analysis of electrical potential of MFCs using four different wastewaters Four different waste water maintain above were feeded batch wise in four different MFCs and electrical potential analysis was carried out by measuring power generated in voltage (Abhilasha S Mathuriya, V N Sharma 2009, B.M.Mali, 2012 Huang L and Logan B. E., 2008).

Results and Discussion

MFC sets used during research work

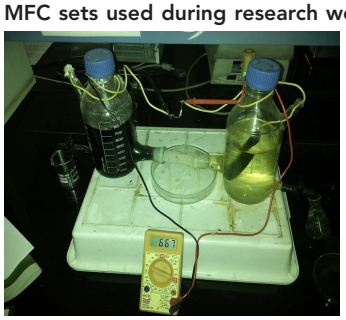


Plate1:Double chambered glass MFC Constructed at Omega glassworks Bombay, India

Plate2: Other MFCs set up used during work at laboratory

Standardization and working of MFC

Fig 1:Synthetic waste as anolyte and distilled water as catholyte

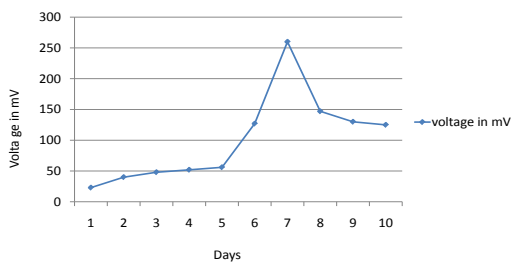


Fig2:Standardization and working of MFCs in terms of voltage

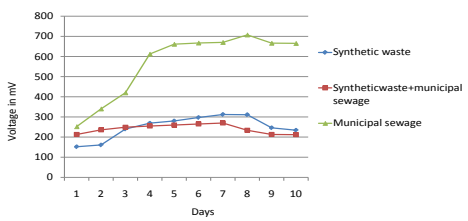
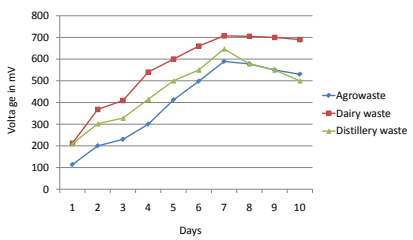


Fig3:Electro potential analysis of industrial waste



All the experiments were conducted 3 times and results were taken as average values.

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Results A single set of double chambered MFC was designed using two 1litter glass bottles (plate1) and it was constructed at Omega glassworks Bombay, India and three other sets were prepared using 1liter plastic bottles (plate2) at laboratory. All these sets were used to analyze generation of electricity using four different waste waters as substrate. The figure 1 shows electricity generation using synthetic waste water as anolyte and distil water as catholyte and optimum being 260Mv. Figure 2 shows standardization of glass MFC and replacement of synthetic sewage by municipal waste water sample as substrate, the optimum electricity generation using this waste was 700 mV. Figure 3 shows electricity generation by MFCs constructed with plastic bottles, utilizing three different industrial wastes waters among which the highest voltage was 707 mV given by Dairy waste water sample and other two were Distillery waste water sample 647 mV, and 589 mV by Agro waste water sample. All the figures show gradual increase in electric potential and the highest at seventh day after that it decreases.

Disscussion Current research successfully progressing toward goal of achieving good electricity generation using mediator less MFCs which confirms the fact shown by Bond and Lovley that the bacteria did not require soluble mediators, but can donate electrons directly by adhesion to the electrode surface (Bond and Lovley, 2003).
Similar to Abhilasha Mathuriya ,during current research local area waste samples were applied to study electricity generation efficiencies (Abhilasha S Mathuriya, V N Sharma 2009).
Summery During present research the MFCs constructed and operated gives successful experimentation with highest of 707mV current generation by Dairy waste water sample.
Conclusion As there is power generation during MFCs operation with municipal sewage and industrial wastes water samples as substrate, the sustainable energy that is bioenergy in terms of bioelectricity production can be achieved successfully.

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