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Bio-electricity generation from sugar mill waste water using MFC

Abstract

Microbial fuel cells (MFCs) have gained a lot of interest in recent years as a mode of converting organic waste including wastewaters and lingo-cellulosic biomass into electricity. Microbial production of electricity may become an important form of bioenergy in future because MFCs offer the possibility of extracting electric current from a wide range of soluble or dissolved complex organic wastes and renewable biomass. In this regard, the study was made to see the potential of sugar mill wastewater for a bio-electricity generation. Double chamber microbial fuel cell was used for sugar mill wastewater as a substrate for electricity generation. The different parametric effect was used to investigate the optimum condition for electricity generation

Keywords: Biotreatment, Electricity Generation, Sugar Mill Waste Water, MFC

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Introduction

Microbial fuel cells (MFCs) appear as a new possibility for the treatment of organic wastes.[1–3] They are similar to conventional fuel cells but make use of electro-active microorganisms as catalysts for the oxidation and/or reduction reactions. In the typical case, a biofilm of these microorganisms oxidizes organic matter in the wastewater, obtaining carbon and electrons. After consuming part of their energy for growth, bacterial cells transfer the electrons to the conductive biofilm matrix, or eventually to an external electron shuttle. Finally, during the electrochemical oxidation (anodic reaction) of redox molecules located at the biofilm/electrode interface, electrons are transferred to the electrode.[1–4] After traveling through an external circuit electron are consumed in the cathodic compartment to reduce oxygen (in the typical cathodic reaction), thus closing the electric circuit for electricity production.[3] MFCs are considered an attractive alternative for wastewater treatment because they offer the possibility of generating electrical energy directly from the oxidation of organic matter. They have been studied either as the unique energy recovering process[5–7] or as an additional treatment to be included after an anaerobic digestion step.[2–4] Some studies have demonstrated that the indigenous microbial population of many industrial wastewaters can be used as the source inoculum of electricity-producing microorganisms.[6–8] MFCs have operational and functional advantages over the technologies currently used for generating energy from organic matter. First, the direct conversion of substrate energy to electricity enables high conversion efficiency. Second, MFCs operate efficiently at ambient temperature.[5]

Third; an MFC does not require gas treatment because the off-gases of MFCs are enriched in carbon dioxide and normally have no useful energy content. Fourth, MFCs do not need energy input for aeration provided the cathode is passively aerated9. Fifth, MFCs have the potential for widespread application in locations lacking electrical infrastructures and can also operate with diverse fuels to satisfy our energy requirements. Some recent developments allow high conversion rates and high conversion efficiencies of simple carbohydrates like glucose, and a complex carbohydrates like starch and cellulose. Although MFCs generate a lower amount of energy than hydrogen fuel cells, a combination of both electricity production and wastewater treatment would reduce the cost of treating primary effluent wastewater. In the present study, I used sugar mill wastewater for bioelectricity production. Wastewater have been examined earlier as a substrate for power generation in an MFC and found suitable for electricity generation due to the food derived nature of the organic matter and the lack of high concentration of inhibitory substances.

Materials and methods

Materials

Speci saccharomyces service used

Sugar mill wastewater collected.

Results and discussion

Electricity generation from sugar mill wastewater using microbial fuel cell was understudy to optimize the parametric effect on that, to measure the potential of sugar mill wastewater different operational parameter were under study.

Effect of oxygen flow rate on electricity generation

During the running of the microbial fuel cell, different ranges of oxygen flow rate were tested to investigate the optimum condition for electricity generation from sugar mill waste water. From 100-250ml/min was analyzed periodically to measure the voltage generation using 50Ω resister with the help of digital multimeter. In Figure 1, it is clearly observed that when oxygen flowrate increasing up to the level of 200ml/min voltage generation were also increased up to the 360 mg/l after a 24-hour period of time for microbial growth.

Effect of pH on electricity generation

The microbial growth of Saccharomyces cell during the running of microbial fuel cell affected by pH due to tolerable pH ranges of microbe's species increased. From 4.5 -5.5 were tested with step size .5 using buffer solution to maintain the pH ranges according to required range of pH under a 48hr running period of MFC. The maximum voltage generated from the microbial fuel cell by utilizing sugar mill waste water. In Figure 2 effect of pH on electricity generation clearly observed.

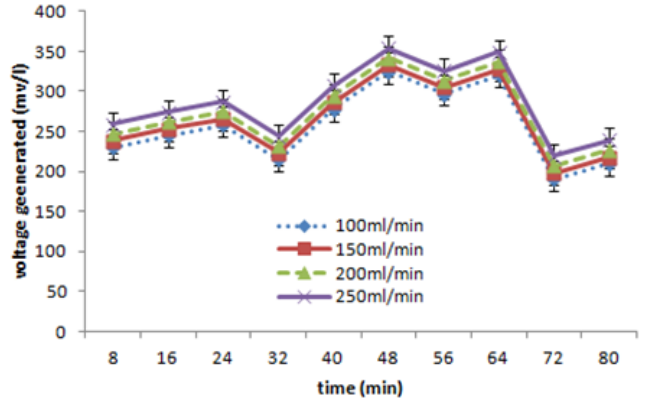

Figure 1 Effect of oxygen flow rate on electricity generation.

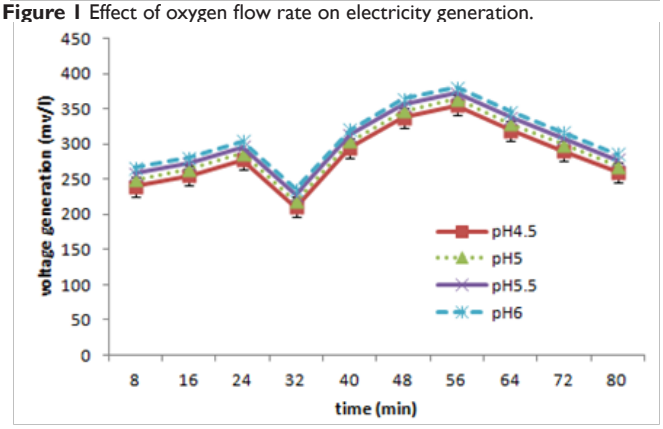

Figure 2 Effect of pH on electricity generation.

Effect of substrate utilization on electricity generation

Power production was observed to increase with the increase in the substrate concentration (Figure 3). Starting from about 10% concentration of the substrate, the power obtained at this substrate concentration was 0.725V. At the substrate concentration of 70% power generation was increased by 2.5V. Further increases in the concentration up to 100 % resulted in the decrease in power production by more than 100% when it reached the value of 1V. This was probably due to the reduction in the activity of the enzymes owing to various factors such as pH. This also indicates that higher concentration of the substrate could actually affect the anode performance significantly resulting in simultaneous lesser power production.

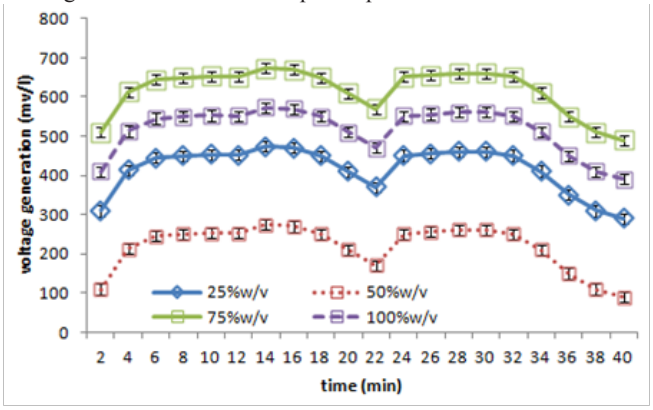

Figure 3 Effect of substrate utilization on electricity generation.

Conclusion

Microbial fuel cell had many advantages overutilization of Sugar mill waste water. It can be easily extracted out energy from primary fermented sludge by utilizing as a substrate in a microbial fuel cell with Saccharomyces cell present already in it. Different parametric effect on electricity generation was investigated.

Acknowledgement

None.

Conflict of interest

The author declare that they have no conflict of interest.

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