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To Investigate the Optimized Conditions of Salt Bridge for Bio-Electricity Generation from Distillery Waste Water Using Microbial Fuel Cell

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Abstract
With the development of the industrial revolution, environmental pollution greatly affected by various pollutants emitted from industries. Apart from this energy requirement also increased due to growing civilization. Ethanol production from molasses is well known regarding its utilization to make environmentally friendly and meeting the energy requirement. Wastewater draws off after distillation of alcohol, that water contains a significant amount of organic matter. Microbial fuel cell (MFC) is one of the major sources for treating wastewater and generating electricity. During running of MFC proton transfer could inhabit by variation of agarose, salt concentration and length, and dia of a salt bridge. The salt bridge is one of the important accessories of MFC. The current study focused on the salt bridge that is used for proton transfer. The salt bridge could make beneficial results by optimizing the concentration of agarose, salt concentration, length and dia of the salt bridge. This study deals with electricity generation from distillery waste and factor affecting salt bridge used for proton transfer. The maximum voltage and electricity generation were seen at 10%agarose, 1MKcl, 1MNaCl, 5 cm length and 1cm diameter of the salt bridge about 0.67 mv and 0.0642 mA. It seems that by changing the percentage of agarose, salt voltage generation could alter.
Keywords: Microbial fuel cell, waste water, sugar cane molasses, and distillery waste water

Introduction

The increasing problem of water pollution due to the development of industrialisation could create a problem for human health as well as aquatic life. Pollution can be reduced by adopting latest and suitable techniques to overcome on the pollutants. AMFC is one of the modern technique which is currently focused by researchers to generate electricity and treat wastewater [1-3]. MFC gives the opportunity to meet the requirement of energy and it plays an important role in renewable energy resources. In MFC chemical energy is converted directly into electrical energy [4]. MFC technology produces electricity from different materials such are complex organic matter, natural organic matter, and renewable biomass. [5MFChelps in the diametrical growth of algae reduces wastewater pollution by, increases production of biomass and convert the said source in electrical energy. Microalgae are inserted in the anode chamber to work as a substrate, as the substrate addition is increased the trend of electricity is headed while other optimising conditions were studied. The maximum power flux(1926 ± 21.4) W/m^2 (8.67 ± 0.10 W/m^3, at Rext = 100 X) and Coulombic efficiency (CE) of 6.3 ± 0.2% were sort out at 2500 mg COD/L of microalgae powder (0.5 g/L).Microalgae captured CO2 (5–14%, v/v) to produce a biomass concentration of 1247 ± 52 mg/L.[6]apart from the technique which employed in wastewater treatment utilised for bioelectricity generation and could solve the problem of different pollutants. Fuel cell operation yielded improved substrate degradation (COD, 72.84%) compared to the Fermentation process (~29.5% improvement). Treatment in MFC distillery waste watercolour intensification in a normal manner [7].Energy generation from waste material was achieved through bacteria which converted organic matter into electricity using MFC technology. Bioelectricity generation is achieved by maintaining two different circumstances in the anode chamber, a cathode chamber, aerobic and anaerobic respectively [8,9]. After transferring through external circuit electron add in cathode chamber to reduce oxygen, a forming a close circuit for bioelectricity generation. [10] All experiments regarding electricity generation were performed using Microbial Fuel. In all experiments anaerobic conditions were employed over the duration of time period about 6 days/, for making salt bridge PVC pipe was employed to take a solution of agar salts and other common salts such are KCl, NaCL. The performance of microbial fuel cell was checked by altering in voltage, current etc. all readings were checked after every hour. The outcomes values are 0.825 V, 0.0113 μA, 0.009223 μW and 0.000000947 mW/m^2 [11]. The microbial fuel cell could make possible results regarding treatment and energy generation from wastewater. During running of microbial fuel cell bioelectrochemical reactions catalyzed in the anodic chamber. Like biochemical, physical, physicochemical, electrochemical and oxidation (cohesively termed as bioelectrochemical reactions) as a result of substrate metabolic activity [12-15] The current work focused on investigating the effect of parameter on performance of MFC through salt bridge by varying concentration of salt agarose, dimension such are dia and length to promote the maximum current generation.

Materials and Methods

Materials

Wastewater

Samples of wastewater were collected from different distilleries of Sindh province.

Microorganism

Yeast *S. Cerevisiae* M-9 is used as the main source of microorganism [16, 17], while it was purchased from local market with the analytical grade. Yeas preparation took place in columns to check the growth of yeast and working of MFC, yeast, glucose, extract, pH, incubation and shaking were the major parameters which were adjusted and optimised to enhance electricity generation. A mixture of all ingredients needed for MFCwas mixed with different ratios as given below. 250 ml medium which contained glucose, 10 g/L, $(NH_4)_2HPO_4$ 0.64 g/L, and yeast extract 2.5 g/L at pH culture of microbes split organic matter into an electron and proton degradation of organic matter decompose into electron and proton, in which electron flow through the external circuit from the anode chamber to the cathode, in MFC substrate, oxidized through the use of microbes that typically generate proton and electron. The electron transfer through an external circuit to make circuit complete proton enter into the cathode chamber through PEM or salt bridge. To make water when to combine with oxygen. Typical electrode reactions are shown below

Anodic reaction:

$$CH_3COO^- + 2H_2O \rightarrow 2CO_2 + 7H^+ + 8e^- \quad 1$$

Cathodic reaction:

$$O_2 + 4e^- + 4H^+ \rightarrow 2H_2O \ldots\ldots\ldots\ldots\ldots\ldots 2$$

The above equation 1 & 2 shows the reaction observed at anode and cathode. In equation organic matter decompose into proton and electron and in equation 02 proton combine with oxygen to make water through oxidation. Electron flow through external circuit could make electricity generation.

Preparation of anode and cathode chamber

Two chambers were fabricated with a salt bridge made from a plastic material having the following dimension. Salt Bridge made from different composition

Items	Height (cm)	Dia (cm)	Length (cm)
Cathode chamber	15	9	-
Anode chamber	15	9	-
Salt bridge	-	1&2	1.5, 3, & 5

Preparation of salt bridge

The salt bridge used for bioelectricity generation in addition to following material 5M NaCl and agarose salt concentration from 7% to 12%. The salt bridge was put a PVC pipe varying its length and dia as given. Proper safety 5.5 and incubated for 18 h on an orbital shaker at 150 rpm maintaining its temperature at 30°C.

Methodology

Process of electrogenesis from MFC

Microbial technology that leads to treating wastewater, as well as same time energy generation, could play an important role to reduce energy crises and making environmental friendly. [18]. Microbial fuel made up of two chambers anode and cathode chamber. Fig 01 represents schematic representation of the process of electro genus of organic matter degradation with the utilization of microorganism. Two different conditions were maintained anaerobic in the anode and aerobic in cathode chamber [19].

Construction of MFC

MFC consists anode and cathode chamber. In anode chamber measures were taken to ensure complete sealing of anodic chamber by means of applying epoxy to ensure anaerobic conditions. The external circuit was accomplished by connecting a resistor (10 Ω) between the two leads of the electrodes

Bioelectricity generation from distillery wastewater as substrate in MFC

Fig. 1: Process of Bioelectricity Generation in MFC

Bioelectricity generation was observed by maintaining the aerobic in the cathode and anaerobic in the anode chamber. In anode chamber Substrate (distillery waste water), was put and giving 10-15 hours for the growth of microbes.

While in cathode chamber oxygen provided that oxidize proton draw off from the anode to make water. (*Saccharomyces cerevisiae*) was used as microbes for degradation of organic matter present in distillery waste water. Created proton transferred through the salt bridge into cathode chamber for oxidation. Electron transferred through the external circuit from anode to cathode for making electricity through 10 Ω resistor.

Results and Discussion

Wastewater samples were collected from distilleries for bio-treatment. MFC technology was used to treat the wastewater and also generate electricity simultaneously. The different parameter for water treatment and electricity generation were optimised to achieve best results.

Substrate for MFC collected from alcohol distillery plant for bioelectricity generation. distillery wastewater characterized in table

Effect of Salt Concentration on Electricity

Effect of Agarose Concentration on Electricity Generation and Voltage Generation

In MFC salt bridge made of different salt, in which agarose had importance role. Different agarose concentration was used in salt bridge and this concentration was tested through variation in Electricity generation from wastewater. From 7-12% agarose concentration were analysed for current & voltage generation. The maximum electricity generation and voltage generation occurred at 10%agarose concentration. The maximum voltage generation at 10%agarose concentration was achieved round about 0.67 mv and electricity generation 0.0642 mA using a 10-ohm resistor in Fig.01.

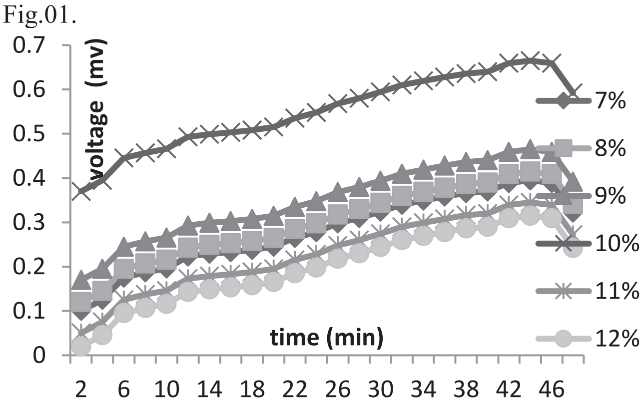

Fig. 2: Effect on voltage generation by using different agarose concentrations

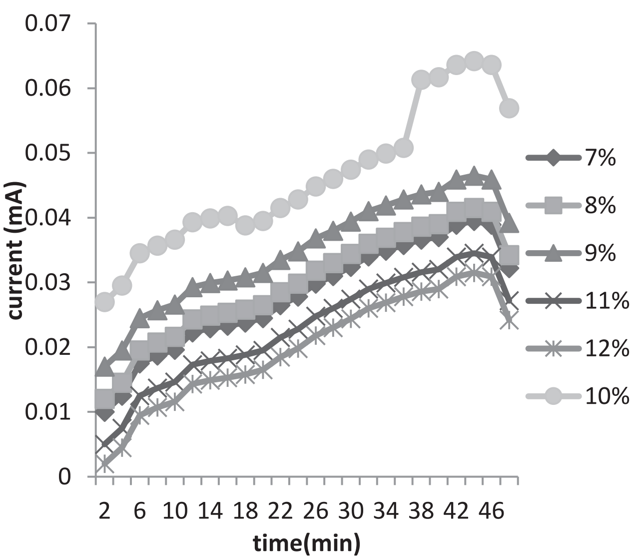

Fig. 3: Effect on current generation by using different agarose concentration

The Fig.3 indicates the particular creation of highest voltage concerning the particular progress challenge involving microorganisms inside the anaerobic chamber depicting the initial enhance in the voltage through the experimental cycle connected with progress curve although goes in some sort of positioned voltage cycle in addition to minimize for the reason that the minimize because the startup goes into decline period because of the demise of microorganisms attributing towards the weariness of nutrition within the particular holding chamber. The generated voltage shows a hike from 7% to 10% concentration agarose, which could be for the reason that concentration of agarose boosts, the gel is extremely polymerized, suppressing the particular inter possibility of the segregated chamber liquids.

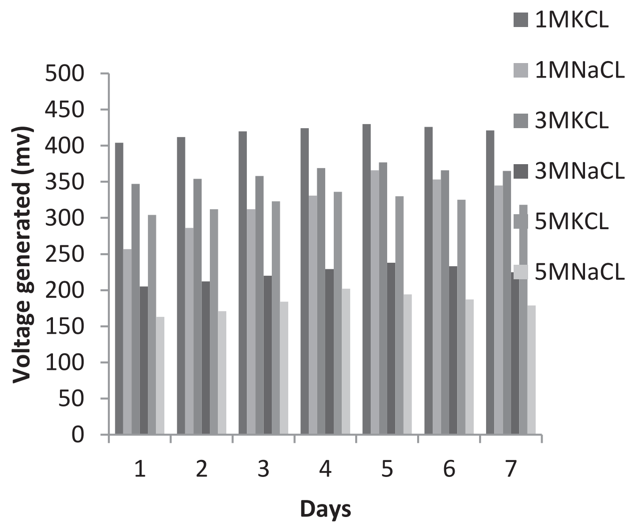

Fig. 4: Effect on voltage generation by varying salt concentration

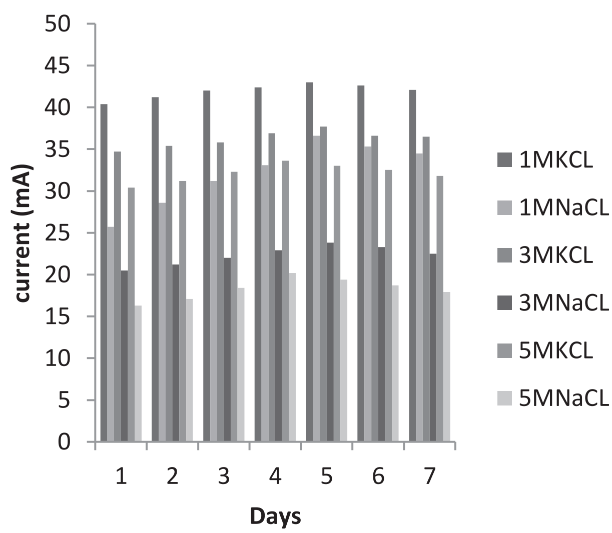

Fig. 5: Effect on current generation by varying salt concentration

Extremely polymerized gel, in addition, inhibits the particular admittance of indigenous as well as oxygen from the cathode chamber by the salt bridge penetration, keeping the anaerobic conditions of the anodic chamber. A decrease in the creation of voltages was analyzed regarding 11% as well as 12% agarose concentration, for the reason that salt bridge extremely polymerized minimizing the sizing, limiting the movement of the proton through the salt bridge. In fig 04 it is clear highest values were produced at 10% concentration of agarose at the end of 38 minute and after this, the maximum value gradually decreases due to the decreasing levels of organic matter's concentrations.

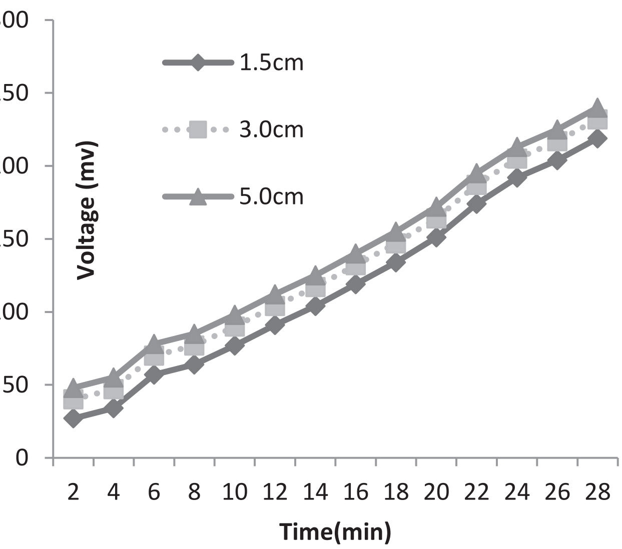

Fig. 6: Effect on voltage generation by varying of length of salt bridge

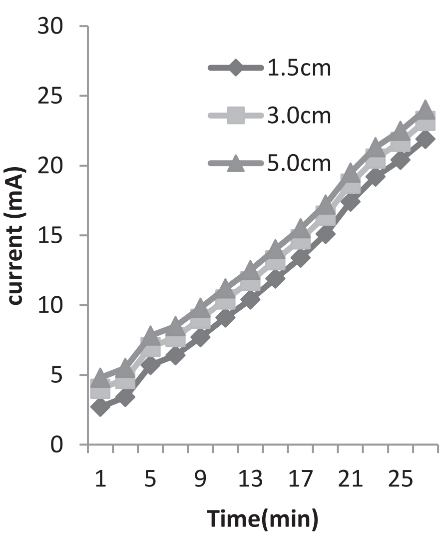

Fig. 7: Effect on current generation by changing length of salt bridge

There is an increase in values as the concentration of agarose enhance from 7% to 10%, this is due to the effective transfer of protons and as the gels are highly polymerized, thus maintaining anaerobic conditions and increasing the growth of microorganisms. But there is a reduction in values for 11% and 12% concentrations of agarose as the highly polymerized gel prevents the effective transfer of protons.

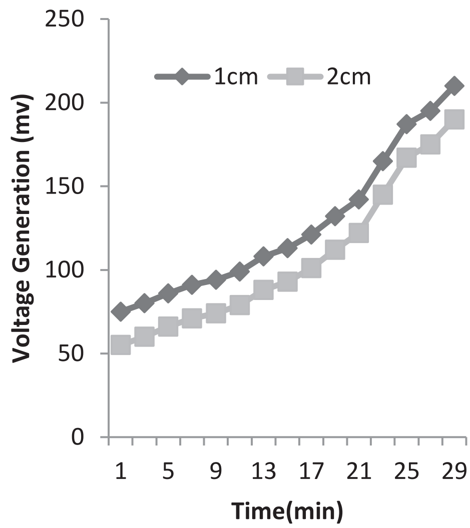

Fig. 8: Effect on voltage generation by changing dia. of salt bridge

Fig 05 describe the behavior of salt concentration in the salt bridge to maximize voltage generation Molar concentration of salt is important regarding dissociated ion to make possibility to transfer proton through a salt bridge. The experiments observed through whole work shows increasing percentage of salt in the salt bridge could decrease voltage generation. Regarding this change could make Optimum results for the salt bridge using 1M NaCl.

Effect of different Length of Salt Bridge on current and Voltage Generation

In MFC Salt Bridge was use at the place of PEM transferring a proton from the anode to the cathode chamber. Different length of salt bridges was used to identify the optimised length for electricity and voltage generation using MFC. The maximum electricity generation was observed at the 3cm length of the salt bridge. At optimized length for the generation of voltage and electricity is presented in the following graph which shows that the maximum values are achieved as the length is increased. It can be explained on the basis that the 3 cm length of the salt bridge might have reduced the resistance of the salt bridge to the proton flux through it and hence resulted in maximum OCV (open circuit voltage) production.

Effect of different Diameter of Salt Bridge on Current and Voltage Generation

The diameter of the salt bridge has many advantages regarding proton transferring from anode chamber to cathodic chamber for oxidation with air to treat wastewater and generate electricity uninterruptedly. Two diameters were used for checking their effects first dia.1 and second dia. 2

respectively. Maximum electricity (current and voltage) production were observed on 2 cm dia. Shown in Fig 08. Maximum electricity (current and voltage) production were observed on 2cm dia about 210 mv/l but as for 1cm dia concerned 190 mv/ Fig 09 indicates the trend of time versus current generation at 1 and 2 cm dia of the salt bridge when varying the dia of the salt bridge made in PVC pipe. The maximum current generation was seen by using 2 cm diameter about 21mA. It is clearly indicating the dia could make modification in electricity generation

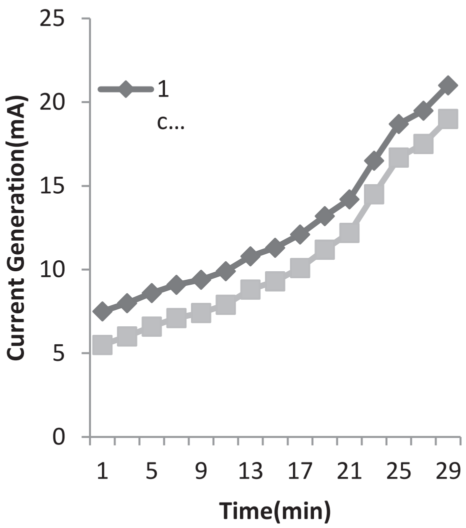

Fig 9: Effect on current generation by changing different dia. of salt bridge

Conclusions

MFC is one of the important researched technique for degradation of organic matter present in wastewater into electricity. During running of MFC it would be affected by different parameters that must be considered. Behind this study performance of MFC tested through changing the parameter of a salt bridge. Salt bridge containing many salts. The maximum voltage and electricity generation was observed at 2 cm dia, 5 cm length, 10% agarose concentration and salt concentration of 1MKCl, 1MNaCL about 0.67 mV and 0.0642 mA. It was clearly noticed during running of much that salt bridge could make reason to decrease the voltage and current generation by variation in salt concentration, agarose, dia and length because, during degradation of organic matter, it splits into electrons and protons, proton transferred from anode chamber, not in smooth direction, and inhibits the electricity generation. Further, study to be made for scale up of MFC for sustainable development.

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