256. Study to Investigate the Optimize Blending Ratio of Cow Dung Manure with Distillery Waste Water for Power Generation in Microbial Fuel Cell

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Abstract

With increasing energy concern world researchers attracted towards the renewable source of energy. Based on energy crises as well as waste water treatment concern microbial fuel cell were used as affordable technology for energy generation and for treatment facility. Study were carried out to investigate the effect of blending ratio of cow dung manure and distillery waste water over power generation. Different blends of cow dung manure with distillery waste water were used such are 25/75,50/50, 75/25. The maximum power production was measured at 50/50 about 2400 mv/l. and minimum 240mv/l for ratio 25:75. The addition of cow dung manure could benefit for power generation with distillery waste water.

Key words: Blending Ratio, Cow Dung Manure, Distillery Waste Water, Power Generation, Microbial Fuel Cell

1. Introduction

Microbial fuel cell get attention regarding their operation for converting biomass into useful energy through bio electrochemical reaction. In Microbial Fuel Cell electro active bacteria were used as biocatalyst for electricity generation [1]. Different factor impact was investigated by the use of mathematical models, that have been proposed to explain these factors which effect on overall performance of microbial fuel cell [2]. This technology suitable for producing energy, which were proposed for different application. Waste water treatment and nutrient recovery are one of them. [3]. It was a clearly identify that MFC had ability to treat urine [4], and in some other examples, H2 production has been reported [5]. Treating urine in MFCs was recently scaled up to pilot scale [6]. It was successfully demonstration of fuel cell that can utilize urine as substrate for power generation. [7]. Bio electrochemical also beneficial for chemical synthesis [8], can also extract out value added metals reduction at the surface of anode described by Wang et al. [9]. Irrespective of application and design, the important parts of MFC are the anode and the cathode. On the basis of these parts overall performance of the MFC can be determined. The changes that will alter the performance of MFC are biofilm thickness and adsorption of compound on surface of electrode [10]. The problem associated with cathode regarding biofilm that approach could cause in oxygen reduction rate. When aerobic activated sludge or pure cultures of phototrophic employed as the biocatalyst [11]. Similarly, the utilization of the laccase enzyme, an enzyme synthesized by several fungal species, which reduces O2 to H2O, leads to improved performance and extends the lifetime of the cathode [12]. Unwanted growth of biofilm on component of mfc could cause to destroy the overall performance [13]. Regarding this problem Behera et al. Report that long term running of mfc could cause the problem of bio fouling or fouling on membrane. [14] Pasternak et al reported that power drop observes after 35 days' operation of MFC made from ceramic [15] as air cathode mfc were concerned made from four types of ceramic materials decrease of their performance after 32 days of operation [16]. However, from different study no one prove still regarding power drop due to bio fouling on cathode [17]. Chung et al. [16] reported that deterioration of cathode could cause through biofilm formation. Apart from this problem cleaning with 10% HCL for one hour could decrease the performance of cathode on the basis of that problem. Yuan et al. [18] also investigated problem. Nevertheless, biofilm growth until not getting any proposed solution for their treatment... at macroscopic level work, it is essential to investigate performance of microbial fuel cell with regards to biofilm formation. In field with respect to convential fuel cell, problem associated with cathode deterioration and suitable strategies has been developed to representing this problem [19]. In MFC different studies report that detoration performance [20], environmental/experimental conditions and material degradation [15,21]. In particular, bio fouling is one of the important factor, that has been reported [15,16]. Present study related to investigated the blending of cow dung manure with distillery waste water.

2. Materials and Methods

2.1. Materials

2.1.1 Microorganism

Saccharomyces cerevisiae M-9 [22] were utilized as biocatalyst for microbial growth in MFC for electron and proton generation to promote electricity generation. This microorganism was purchase from local market with analytical grade. Inoculums prepared for Saccharomyces cerevisiae having following composition with 250 ml medium which contained in g.l-1: glucose, 10; (NH4)2 HPO4, 0.64, and yeast extract 2.5; at pH 5.5 and incubated for 18 h on an orbital shaker at 150 rpm at 30°C.

2.1.2 Distillery effluent characteristic

Distillery effluent were collected from al Abbas distillery plant and analyzed given in table 01,

Table 1

Characteristic	pH	Colour	Bod (mg/l)	COD (mg/L)	Total Solids(mg/L)	Dissolved Solids (mg/L)	Chlorides (mg/L)	Conductivity (mS/cm)
Value	3.99	Dark brown	3665	89820	74022	59721	6912	20.1

2.1.3 Cow dung manure

Mainly cow manure consist of different organic matter that presents on the basis organic compound presents in cow dung it were utilized in anode chamber of MFC with distillery effluent for electricity generation.

Fig 1 Typical MFC Camera View

2.2 Methodology

2.2.1 Configuration of MFC

In construction of microbial fuel cell two bottles made from polycarbonate material were used for anode and cathode chamber. Salt bridge provided to make complete circuit which is made through PVC pipe having dimension (4 cm × 1 cm). Typically salt bridge composed of normal salt and agar salt which is about 10gram. Adhesive material was used to connect salt bridge with two bottles. The electrodes made from carbon cloth having dimensions (4 cm × 4 cm). for completion of electron flow circuit copper wire was added with electrodes. Fish pump were provided for aeration rate for making aerobic condition in cathode chamber.

2.2.1.1. Preparation of anode and cathode chamber

Microbial fuel cell is basically construct of two chambers coupled salt bridge. Two chambers are made from polycarbonate material which is about 3litr in volume. Working volume is 80% because space for gaseous pressure emit during digestion of waste into useful product electron and protons. Electrons flow has been successful with addition of electrodes that could increase power production and proton transfer from anode to cathode by salt bridge. Different ph ranges were tested to identify the pH value where maximum growth of microorganism occurs. In Cathode chamber aerobic condition were maintained which promoting proton coming from anode chamber for oxidation.

2.2.1.2 Preparation of salt bridge

Salt bridge was prepared from different salt such are Nacl Kcl and agar salt for making gel like membrane for transferring of proton from anode to cathode chamber.

2.2.2 Running of MFC

MFC were operated at different operation parameter such are aeration rate, pH and substrate concentration couple with different blending ratio of cow dung and Distillery effluent. After 24 hr growth of microorganism current generation were observed with different time intervals. Maximum power generation observed after 48hr about 55mW. Different condition for running of MFC were maintained in anode chamber anaerobic and aerobic in cathode chamber. Salt bridge were utilized by altering different concentration of agar salt and common salt for conducting proton coming from anode to cathode. Fig 02 highlight the process of electricity generation from cow dung & distillery effluent.

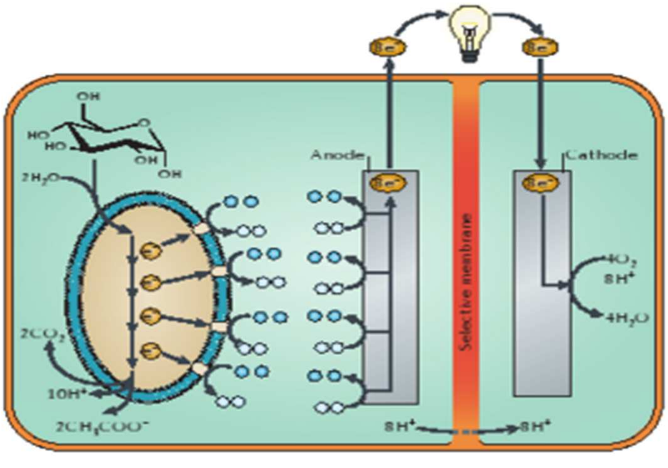

Fig 2 Basic operation of MFC

3. Results and discussion

3.1 Results

During running of MFC different process parameter effect on electrcity generation. different parameter of mfc were tested and analysed. Voltage generation from MFC were measured by volt meter and current, current density, power, power density was calculated by following relation.

$$P=VI \quad (1)$$

Power density = power/ area of anode

Current density = current generated/ area of anode

3.2 Discussion

3.2.1 Power generation from distillery effluent with cow dung manure

Different cow dung and distillery waste water were used to test the maximum power generation During MFC running operation different substrate concentration were used to investigate optimize percent of substrate for electricity generation. at 25%w/v of cow dung manure were tested and analyzed the open circuit voltage generated about 504mv, for 50%w/v of cow dung manure voltage generated maximum due to a substrate that need this amount of substrate and dilution for growth of microbes space in anode chamber. The minimum voltage generated at 100%w/v of cow dung manure. In this regard different slurry concentration were measured in order to get optimized condition for maximum voltage generated. In fig 02 different slurry w/v of cow dung were used maximum electricity generation obtained at 50%w/v.

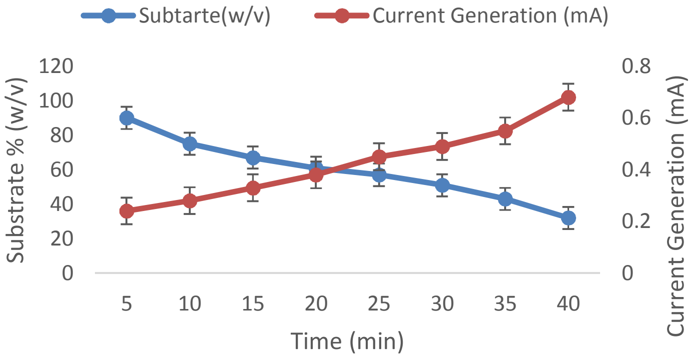

Fig 3 (a) Voltage generated at different time intervals

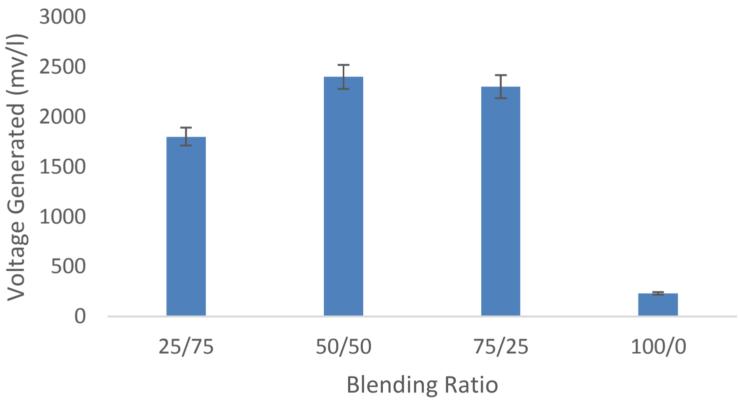

Fig 3 (b) Voltage generated at different blending ratio

3.2.1 Effect of aeration on power generation

Among other parameters aeration rate has also importance for completion power generation circuit. MFC mainly consists of two compartment, in which first one is substrate utilization compartment namely as anode and another is for oxidation of proton that is cathode. In mfc aeration rate were provided to cathode chamber through fish pump, flow rate was controlled by air flow rate. From 90-240ml/min with step size is 50ml/min were analyzed, for maximum power generation fig 04 highlight that 190ml/min could be helpful for maximum current generation about 0.97mA and minimum current generation would have observed at 90ml/min about .83mA. it would be clearly observable that power generation had significant impact by altering oxygen flowrate. it is due to the proton coming from anode chamber could oxidized at cathode chamber. Maximum aeration rate will increase the amount of proton from anode chamber.

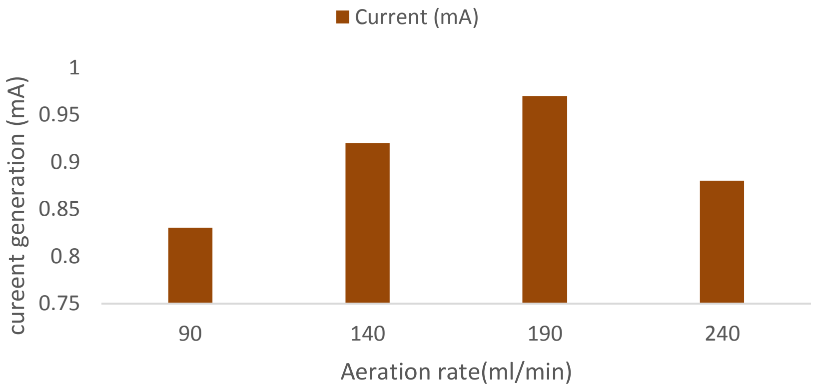

Fig 4 Effect of aeration rate on power generation from MFC at 50/50 of sludge and distillery waste water

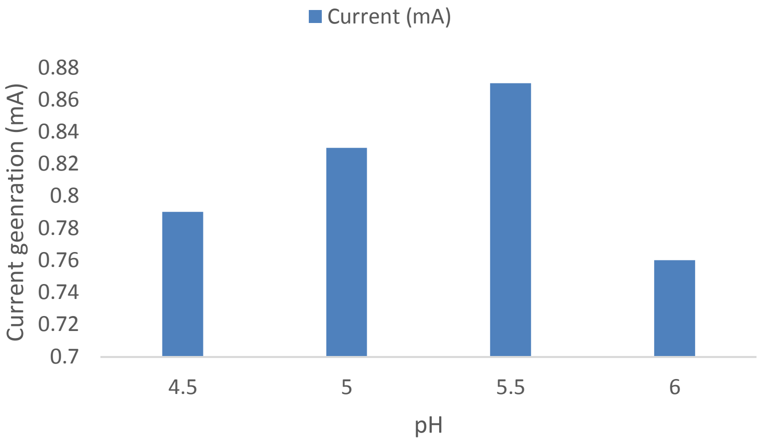

Fig 5 Effect of pH on power generation from MFC at 50/50 of sludge and distillery waste water

3.2.2 Effect of pH on power generation

PH has importance for sort out the Acidity and basicity of any chemical compound. As MFC concerned, in anode chamber of MFC contain substrate for power generation as well as waste water treatment. PH effect were investigated by changing their values with the help of buffer solution and tablets. From 4-6 pH ranges were used to identify the maximum power generation from organic waste or cow dung+distillery waste water. In figure it is clearly observable that maximum power generation would occur at pH value 5.5 about 0.87mA, because microbial growth gets candidate value for converting substrate into useful electron and proton. For as other pH ranges were concerned minimum current generation observed at pH 6 about 0.73mA.

it is clear from that graph pH had important effect on power generation. This is due to the neutralization of that proteins. By viewing these results it is clearly identified that pH has impact on microbial and on voltage Generation [15].

3.2.3 Effect of substrate concentration

In this work different blending ratio of cow dung and distillery waste water were used such are 25/75, 50/50 and 75/25 of cow dung and distillery waste water. Among these three different ratio maximum power generation were observed at 50/50 about 0.88mA and minimum amount of power generation is observed at 25/75% about 0.77mA. This could be due to the decreasing or increasing organic compound present in cow dung or in distillery effluent. For this reason, microbial activity could inhibit by changing the concentration of substrate. Fig 06 highlight the observable concentration of substrate vs current generation.

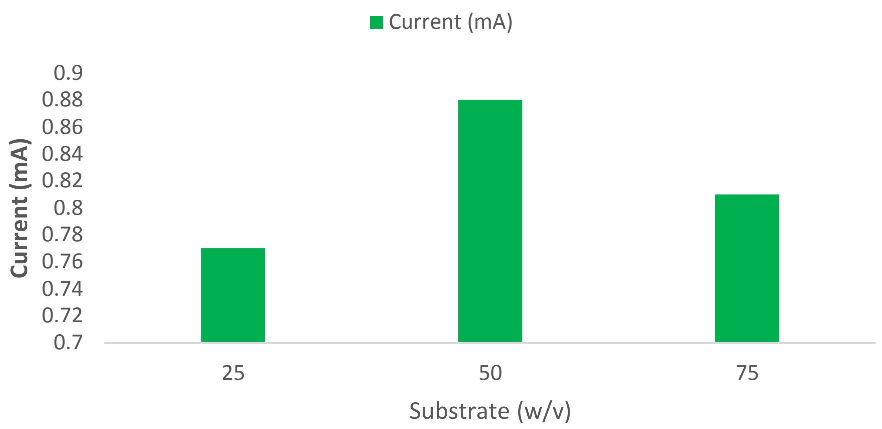

Fig 6 Effect of Substrate Concentration on power generation from MFC

4. Parametric effect of Power and current density on Microbial Fuel cell

In this section power and current density are under consideration. Microbial fuel cell had many advantages over conventional fuel cell regarding mode of their running and operational requirement. In present study different blends of cow dung and distillery waste water were utilized to investigate the optimized condition for maximum power generation. In fig 07 effect of aeration rate vs power density and current density, by changing the aeration arte slightly change in current and power density. The maximum power and current density observed at 190ml/min, it is due to highly value of aeration would not get interact with organism and that's reason 240ml/min did not give high power and current density. By highlighting value 90ml/min could be starting of microbial growth and promoting oxidation of proton coming from anode. In fig 08 it is clearly thoughtful that acidity and basicity representation possible with the changing in pH value, for as microbial growth were concerned tolerable limit for microorganism is from 4.5-5.5 at which microorganism could survive and get healthy environment. Fig 08 highlight the power and current density at different pH ranges, for maximum current and density were concerned 5.5 pH value give maximum value about 65.21mA/m^2 and 76.12 mW/m^2. For as fig 09 were concerned it has been observed that by varying concentration of substrate will automatically change in value of current and power density. For such condition different substrate concentration were utilized, such are 25:75,50:50and 75:25. The maximum current density and power density were observed at 50:50 about 54.21mA/m^2 and 71.12 mW/m^2 respectively.

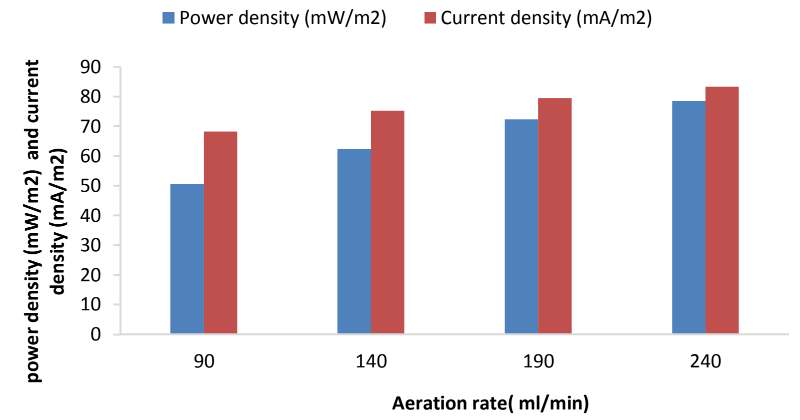

Fig 7 effect of aeration rate on power and current density at optimized blending ratio of cow dung and distillery waste water 50/50

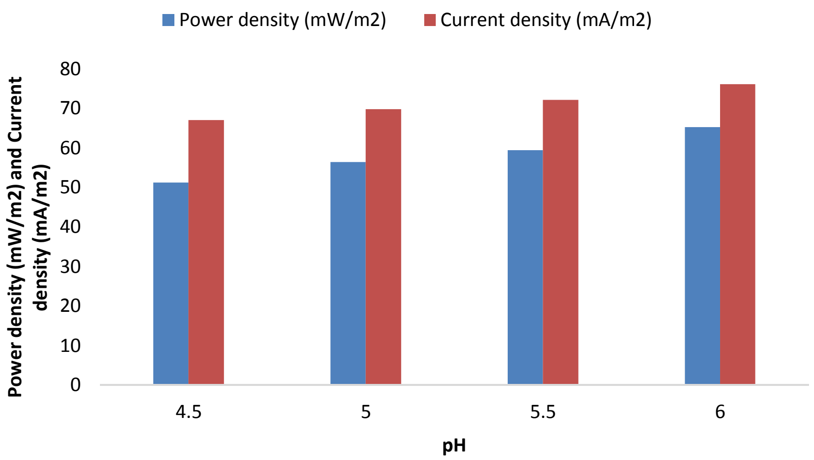

Fig 8 effect of pH on power and current density at optimized blending ratio of cow dung and distillery waste water 50/50

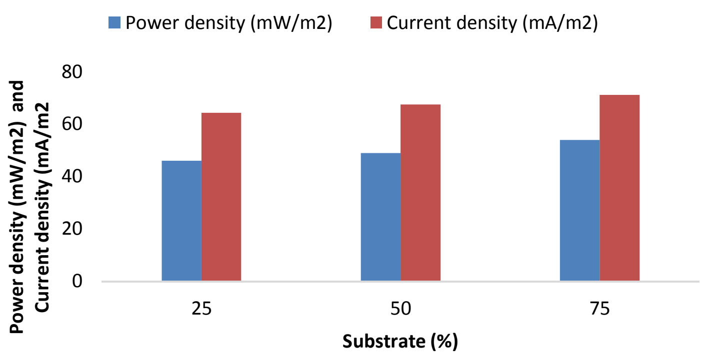

Fig 9 Effect of substrate on power and current density at optimized blending ratio of cow dung and distillery waste water 50/50

5. Conclusion

Increasing energy demand and due to increase interest of researchers in this regard study were carried out to investigate the key factors that inhabit energy production by utilizing microbial fuel cell. Due to rapid revaluation of energy in present scenario, microbial fuel is one of terminus technique for utilizing biomass and converted into useful energy. In this context, energy produced from a potential organic bio waste is an attractive option. Keeping this view, the present work has been undertaken to produce electrical energy from cow dung as bio waste in microbial fuel cell. Different blends of distillery waste water and cow dung manure were tested to investigate the optimize condition Maximum voltage generated at 50/50 about 230mv/l.

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