# Development of Laboratory Scale Microbial Fuel Cell for Electricity Generation from Cow Dung Manure Using Microbes

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**Abstract**

*Development in microbial fuel cell is increasing day by day due to utilizing waste material into useful energy and fulfilling future requirement of energy. Due to nature of microbial fuel cell for converting organic material into bioelectricity using microorganism get part economy of the world, due to waste material disposing and handling problem. The main purpose of this work is to investigate the cow dung manure as substrate for degrading and generation of electricity, different substrate percentage, oxygen, and pH on electricity generation. The maximum voltage were measured using 50%w/v of cow dung manure 801±03mv/l and minimum at 25% about 488±02mv/l, and for as other parameter were concerned 455mv/l at pH 6, and 290mv/l at 35ml/min for air flow rate to cathode chamber for oxidation of proton. It was concluded from the whole work that microbial fuel cell has ability to utilize microbes from cow dung for power generation and presents cleaner technology.*

**Key Words:** Microbial Fuel Cell; Microorganism; Cow Dung Manure; Electricity Generation

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## INTRODUCTION

Recycling waste is the best option for reducing animal waste. Recycling of resources and proper disposal of animal wastes to reduce its impact on the environment is currently a key issue in animal husbandry. A new bioreactor microbial fuel cell (MFC) is expected to play a role in both wastewater purification and energy recovery. However, the production of electricity from cow dung has not been checked. In this study, using MFC, we examined the possibility of power generation from dairy waste, and analyzed the nature of the treated pulp as a resource for liquid fertilizer recycling. MFC treatment of pulp in a dose-dependent manner power generation, MFC chemical oxygen demand / L slurry of the maximum output power of 0.34mW / m2. After treatment with MFC, 84% of the biooxin in the slurry was removed and the three essential fertilizers (nitrogen, phosphorus and potassium) were maintained at 84%, 70% and 91%, respectively. As an element of rapid release fertilizer, the amount of ammonia in the slurry is increased by 1.9 times. Although the treated slurry exhibits a preferred property as a liquid fertilizer, further research in order to improve the power output of the MFC requires practical use (Yokoyama et al., 2006). A microbial fuel cell (MFC) was constructed to investigate the possible generation of electricity using cattle dung as a substrate (Zhao et al., 2012). A microbial fuel cell (MFC) is a device that uses microorganisms as a biocatalyst to convert organic matter into electricity. Most MFCs contain two electrodes separated into one or two chambers, which operate as fully mixed reactors (Min and Logan, 2004). In contrast to conventional fuel cells, microbial fuel cells (MFC) have particular advantages, such as high energy conversion efficiency, mild reaction conditions (ambient temperature, atmospheric pressure and neutral pH), no exhaust gas purification devices, and direct bioenergy conversion Single step. MFC is used to handle many complex substrates such as cow dung manure (Bharadwaj and Kumar, 2012), swine wastewaters (Min et al., 2005), domestic wastewater (Min et al., 2005) and manure sludge waste (Scott and Murano, 2007). The sewage sludge, produced in the course of sewage treatment as an inevitable by-product of the process, presents an alternative organic source as MFC substrate (Dentel et al., 2004). The MFCs inoculated with mixed bacterial cultures (e.g. sewage sludge) exhibited high resistance to process disturbance, high versatility to substrate used, and high yield of power output (Rabaey and Verstraete, 2005). With a porous carbon paper anode electrode, a power of 8 mW / m2 was generated over 50 hours with a Coulomb efficiency (CE) of 40%. When using iron oxide coated electrodes, the power and CE were 30 mW / m2 and 80%, respectively. Methane Suppressors (2-Bromoethane Sulfonate) Increases CE to 70% (Kim et al., 2005). Six separate continuous MFC unit stack configurations use a hexacyanoferrate cathode to produce a maximum hourly average power output of 258 Wm-3. The connection of the six parallel and parallel 6 MFC units allows the voltage to be increased (2.02 V at 228 Wm-3) and the current (255 mA at 248 mA m-3) while retaining the high power output. During a series connection, a single MFC voltage is divergent due to microbiological limitations when the current is increased. With the passage of time, the diversity of the initial microbial community decreased, Gram-positive strains dominated. The transfer of microbial communities is accompanied by a short time power output of individual MFCs increasing from 73Wm-3 to 275Wm-3, a reduction in transmission limits and a reduction in MFC internal resistance from 6.5 ± 1.0 to 3.9 ± 0.5Ω (Aelterman et al., 2006). Five electrophilic bacteria were isolated from cow dung and their electrophysiological characteristics were studied respectively. The bacterial isolate CD64 was found to be the best in the isolate because 710.7 mV OCV was produced at 37 ° C and pH 7.0, and the LB medium was the anolyte as the catholyte. Based on the phenotypic characteristics and 16S rDNA sequencing, the isolates CD64 were identified as Bacillus (Bharadwaj and Kumar, 2012). This work conducted used to developed laboratory scale microbial fuel cell using cow dung manure as substrate.

## MATERIALS AND METHODS

Cow dung manure was collected from different places of Sindh provinces and then used by different concentration from 25-75% w/v. Pure culture of saccharomyces cerevisiae or baker yeast (sigma Aldrich) was purchased from local market in Karachi from which the desired inoculum of 0.5N was prepared as per the standard method 110$^{o}$C (Wei et al., 2012). Sample were collected and analyzed by development of microbial fuel cell shown in figure 1. Typical anode and cathode chamber were prepared from plastic bottles using following dimension given in table 1.

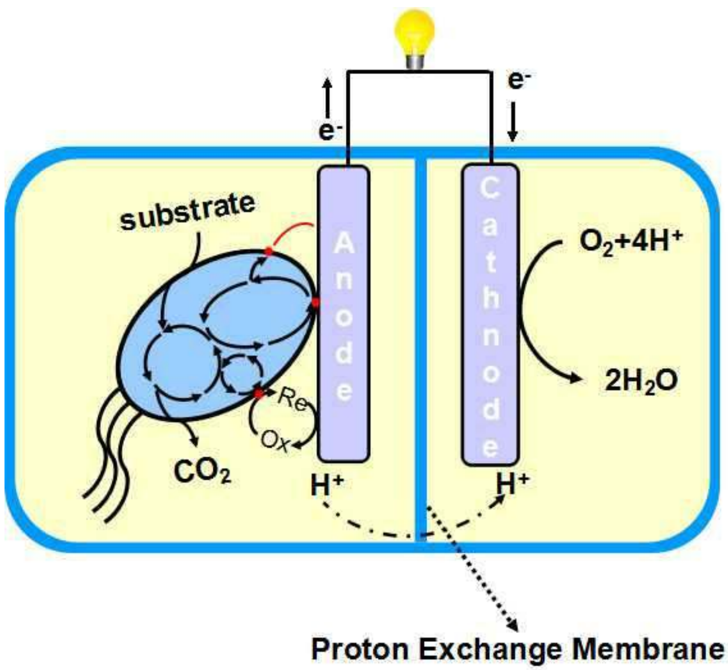


**Figure 1:** Flow chart of electricity generation from microbial fuel cell

**Preparation of anode and cathode chamber**

Anode and cathode chamber was made by using plastic bottles dimension are given in table 1. in anode chamber cow dung manure were used for varying different concentration and in cathodic chamber salt water used aerobic condition were developed by using fish air pump for oxidation process.

**Table 1: Typical dimension for construction of MFC**

| Items | Height (in) | Dia (in) | Length (in) |
|---|---|---|---|
| Cathodic chamber | 15 | 9 | - |
| Anodic chamber | 15 | 9 | - |
| Salt bridge | - | 0.25 | 0.5 |

**Preparation of salt bridge**

Salt bridge was made for transferring proton from anode to cathode chamber by using different concentration of agarose for maximum electricity generation. Typical composition of salt bridge 3 g/l agar salt, 0.1g/l 1MNacl and 0.05g/l 1M kcl.

**Microbial fuel cell running**

The proton transfer is carried out by using a salt bridge to connect the two chamber microbial fuel cell. Through the use of electrodes from the anode chamber to the cathode chamber of the electronic flow occur and make the circuit complete. The air pump is provided with a cathode chamber for oxidizing protons from the anode chamber. After 4 hours, different substrates were loaded into the anode chamber, allowing the microbial fuel cell to run continuously. The power analysis is done by the multimeter.

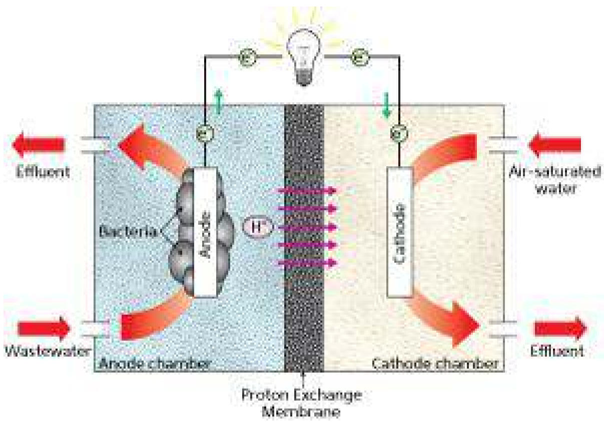


**Figure 2:** Running of Microbial Fuel Cell

**Analysis**

In MFC different parameter were analyzed during experimental work.

**pH**

Different pH ranges for activity of biocatalyst were utilized for getting optimized condition for electricity generation. Because pH had significant effect on microbial activity of microbes. Due to basicity and acidity the pH had significant effect between 6-8.5pH.

**Oxygen flow rate**

During microbial growth aeration rate had significant effect on bio-electricity generation. From 15-60ml.min for cathode chamber regarding oxidation of proton from anode chamber.

**Voltage Generated**

Voltage were analyzed by multimeter coupling with different substrate concentration, pH, and aeration rate. Voltage was continuously measured after 24 hr microbial growth of microorganism by a multimeter with a data acquisition system. Current (I) was calculated from the voltage (V) by I= V/Re, where Re is the external resistance. Power (P) was calculated as P= IV.

## RESULTS AND DISCUSSION

Different substrate and different operational parameter were measured to investigate with Effect of different concentration of substrate on electricity concentration. During the MFC run, different substrate concentrations were used to study the optimized percentage of the power generation substrate. Tested in 25% w / v cow dung and analyzed to produce an open circuit voltage of about 504 mv due to the need for the substrate and the dilution for growth for 50% w / v of cow dung fecal voltage generation. Cattle manure at 100% w / v produces the minimum voltage. In this regard, the different slurry concentrations are measured to obtain the optimum conditions for the resulting maximum voltage. In Figure 2, 50% w / v of different vials of w / v were used for maximum power generation.

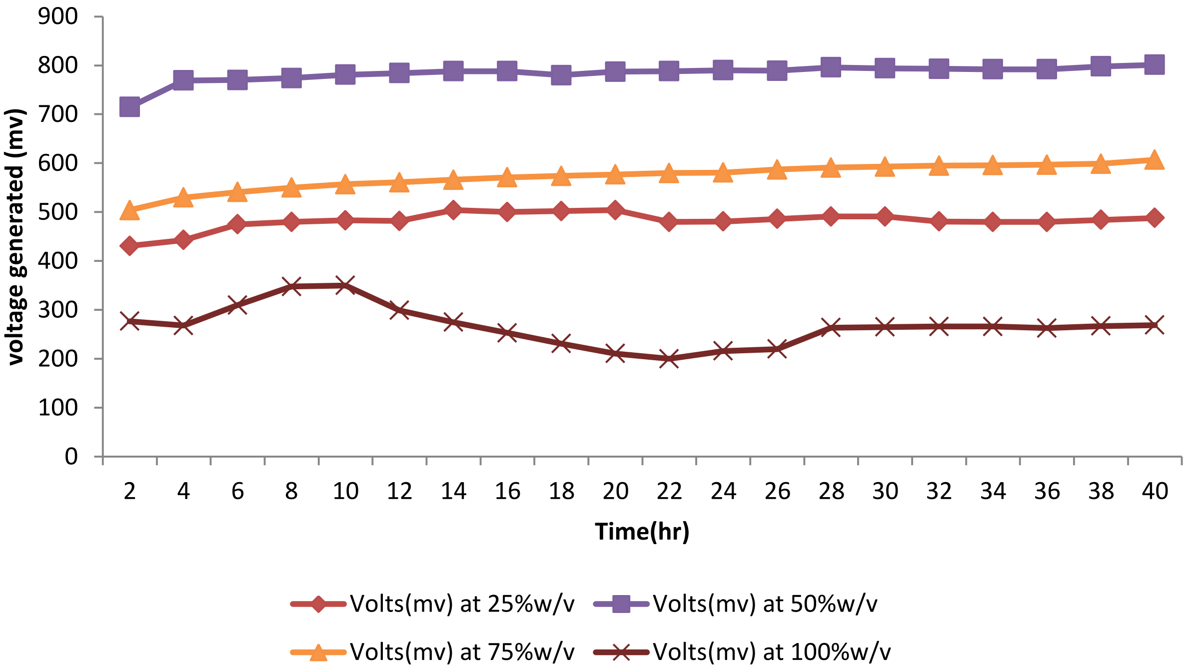


**Figure 3:** Voltage Generated using different concentration of Substrate

### Effect of oxygen flow rate on electricity generation

Effective wastewater treatment using microbial fuel cells (MFC) will require a better understanding of how operating parameters and solution chemistry affect treatment efficiency, but few studies use actual wastewater to check for power generation. Here, the wastewater treatment efficiency of beer brewing wastewater was investigated from the aspects of maximum power density, Coulomb efficiency (CE) and chemical oxygen demand (COD) (Feng et al., 2008). Different oxygen flow rate was tested for maximum power generation in MFC. from 20-35ml/min was used to identify the value for maximum electricity generation. During MFC running oxygen flow rate had importance regarding oxidation of proton coming from anode chamber in cathode chamber through salt bridge. For maximum acceptance of proton cathode chamber need more oxygen in order to get oxidation process quick.

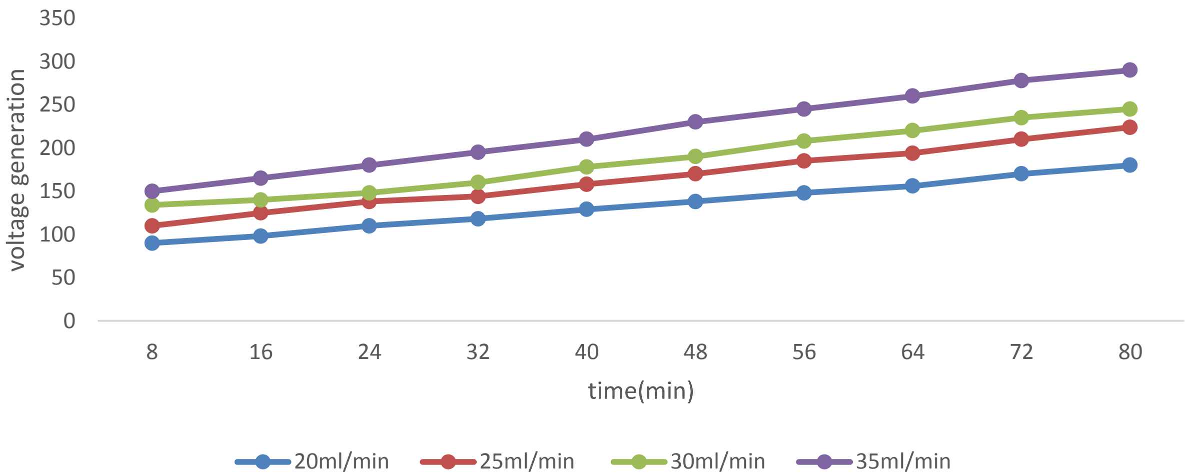


**Figure 4:** Effect of various air flow rate on electricity generation from cow dung manure

**Effect of pH on on electricity generation**

pH had important role in microbial growth for promoting towards energy generation from cow dung manure. From 4.5-6.5 ph were used to identify maximum electricity generation from cow dung manure. pH between 5.8 and 7.4 did not markedly influence the maximum power density and columbic efficiency. However, at a low level of buffer concentration (25 mM) reducing the pH led to higher power density. Furthermore, it was observed that higher concentrations of buffer were beneficial to power generation when pH was at its high level, but negatively impacted the cell performance at low pH levels.(Rabaey and Verstraete, 2005). The highest current was generated at pH of 6.5 in the anodic chamber with CE of 4% (Jadhav and Ghangrekar, 2009). The maximum power generation were observed at pH 6 about 455mv/l.

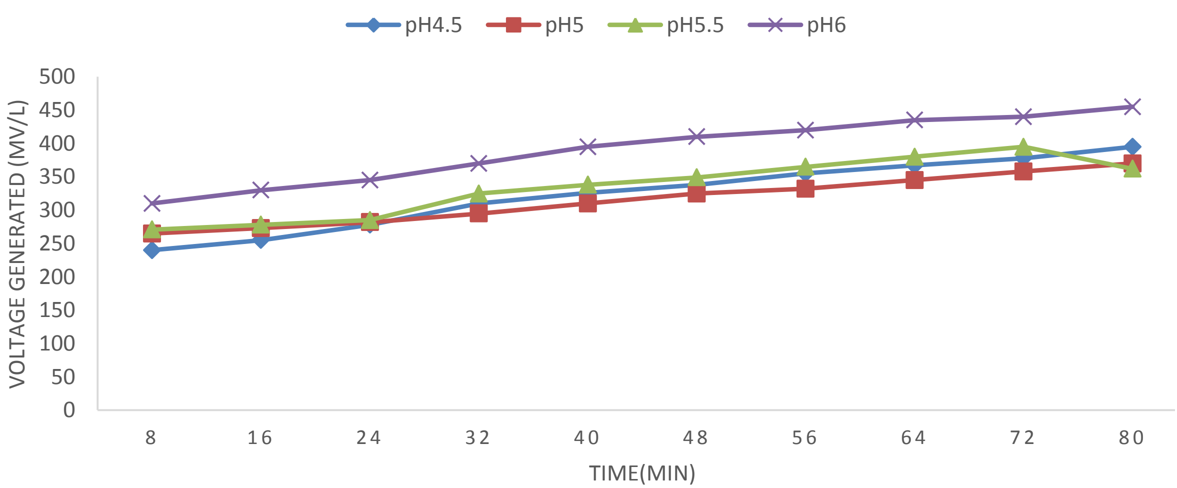


**Figure 5:** Effect of various pH ranges on electricity generation from cow dung manure

## CONCLUSION

Study was conducted to generate electricity from cow dung manure using microbial fuel cell. Different operational parameter were analyzed during running of microbial fuel cell. For aeration rate from 20-35ml/min were used with step size 5ml/min, the maximum voltage generated about 290mv/l at 35ml/min. For as substrate were concerned the maximum voltage generated 800mv/l with the use of 50% w/v when compared with 25%w/v, 75%w/v and 100%w/v. For microbial growth pH of solution had importance on that basis different pH ranges were utilized for making friend environment. From 4.5-6pH ranges were utilized the maximum voltage were observed at pH 6 about 455mv/l. it could conclude that cow dung manure had potential for utilization in microbial fuel cell for power generation.

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