STUDIES ON ELECTRICITY GENERATION FROM EM BALLS IN WASTEWATER TREATMENT

Chanoknant Thongsuk[1],Theerayuth Thongsuk[2], Nopakarn Chandet[1]*,
[1]*Division of Biochemistry and Biochemical Innovation, Department of Chemistry, Faculty of Science, Chiang Mai University*
[2]*Faculty of Agro-Industry, Chiang Mai University*
*Corresponding author: nopakarn.c@cmu.ac.th

ABSTRACT

The increasing demand for alternative energy has intensified due to the depletion of fossil fuel resources and their environmental impacts. At the same time, effective wastewater management remains essential in both industrial and household sectors. Therefore, systems capable of simultaneously treating wastewater and generating energy represent a promising approach toward sustainable resource utilization. This study aimed to investigate electricity generation during wastewater treatment using Effective Microorganism (EM) balls and to compare the performance of commercially available EM balls with newly prepared EM balls in terms of both treatment efficiency and electricity production. The potential influence of EM ball size and surface area on treatment performance was also evaluated. Salt bridges prepared with agar concentrations of 3%, 4%, and 5% (w/v) were tested to determine their electrical performance. In addition, the effects of aerobic and anaerobic anode conditions were examined. Due to the relatively low contamination level of the wastewater used, system stability was assessed using oxygen stability, calculated from dissolved oxygen (DO) values measured by the Winkler method. Additional water quality parameters were analyzed using commercial test kits. The results showed that oxygen stability in all experimental groups decreased during days 7–9, corresponding to the active phase of microbial release and organic matter decomposition. Oxygen stability subsequently increased and reached its highest value on day 13. Wastewater treated with commercially available EM balls (0.6 g, two balls) achieved the highest oxygen stability, approaching 100%, indicating slightly better treatment performance than newly prepared EM balls. Surface area appeared to have only a minor effect on treatment efficiency, though the differences were not conclusive. In terms of electricity generation, the microbial fuel cell (MFC) system successfully produced electricity. The 3% (w/v) agar salt bridge showed the best performance, and anaerobic anode conditions were more favorable than aerobic conditions. The maximum power output detected was 960 mW, which is comparable to the typical power range of a small flashlight. Although the power output remained relatively low and fluctuated due to biological factors, the system demonstrates potential for integrated wastewater treatment and energy recovery. Further optimization is required to enhance overall system performance.

INTRODUCTION

- Increasing energy demand requires sustainable alternatives.
- Microbial metabolism enables bioelectricity generation.
- EM balls contain active microbial communities.
- Their electricity generation potential remains unclear.
- This study evaluates electricity production from EM balls.

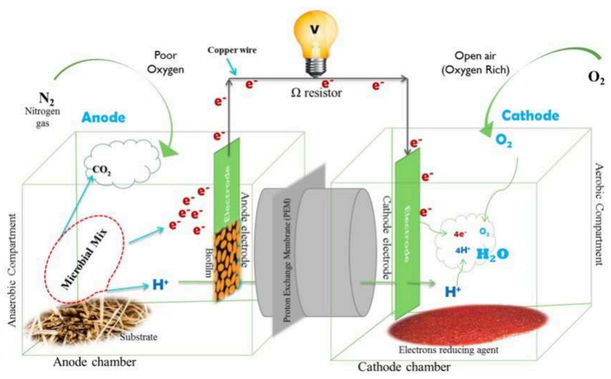


Figure1. Microbial Fuel Cell

Principle of MFC

In an MFC, microorganisms oxidize organic matter at the anode, producing CO_2, H^+, and e^-. The electrons flow through an external circuit to the cathode, generating electricity, while protons migrate through the salt bridge. At the cathode, O_2 combines with H^+ and e^- to form water (H_2O).

Role of EM Balls

EM balls provide active microbial communities that enhance organic matter degradation, promoting electron release and improving electricity generation in the MFC system.

OBJECTIVES

1. To compare wastewater treatment efficiency of EM balls.
2. To evaluate MFC electricity generation under different agar concentrations.
3. To assess the impact of anode conditions on power output.

METHODS

Wastewater sample: from food processing laboratory at the Faculty of Agro-industry, Chiang Mai University

EM balls:

- Commercial EM ball from Aggie CMU Shop, Faculty of Agriculture, Chiang Mai University
- self-prepared EM

The EM solution contained
- Mixed beneficial microorganisms
- Molasses (carbon source)



Rice bran, husk, cactus soil (1:1:1)

Mixed

Mixed with EM solution from Aggie CMU Shop

Shaped

Air-dried for 3–5 days

MFC setup and Experimental Variables:

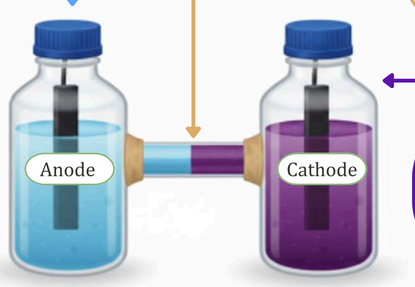
test:
- Oxygen stability test
- Other parameters (commercial test kits)

EM ball type: commercial or Self-prepared

Experimental Treatments
Treatment 1: EM ball 0.6 g, 1 ball
Treatment 2: EM balls 0.6 g × 2 balls
Treatment 3: EM ball 2 g, 1 ball
Each treatment was evaluated for both commercial and self-prepared EM balls.

Anode Condition: Aerobic or Anaerobic

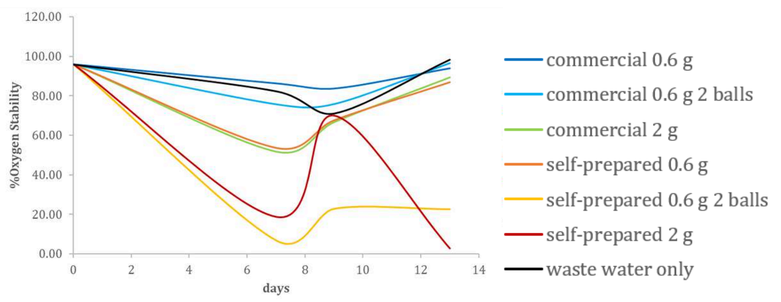
Salt Bridge (agar): 3%, 4%, 5%



Electron acceptor: Potassium Permanganate solution

MFC >>
Real-Time Electrical Monitoring System
>> Data output

RESULTS



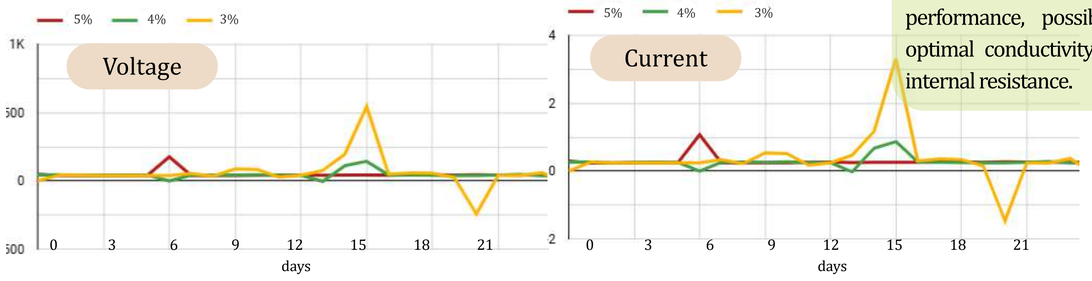
Oxygen stability decreased during days 7–9, likely due to active microbial degradation of organic matter. The subsequent increase suggests that the system has stabilized after substrate reduction. Commercial EM balls showed slightly higher oxygen stability, suggesting better treatment performance; however, the differences were not substantial.

Figure2. %Oxygen stability from 30-fold dilution

Table1. Chemical composition of wastewater after 13-day treatment with EM balls

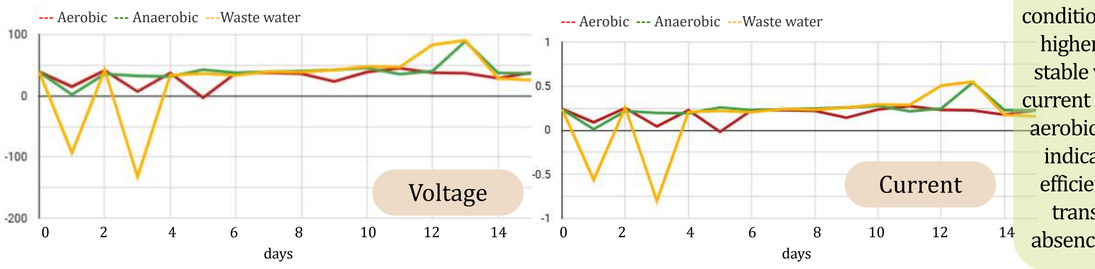
Parameter	Commercial EM ball	Self-prepare EM ball
Nitrate (mg/L)	No significant change	No significant change
Nitrite (mg/L)	No significant change	No significant change
Total Hardness (mg/L)	Improved	Significantly improved
Carbonate (mg/L)	Improved	Significantly improved
pH	Stable (neutral range)	Stable (neutral range)
Phosphate (ppb)	Stable	Stable
Ammonia (mg/L)	No significant change	Significantly improved

The values are approximate, based on colorimetric observations rather than precise measurements, and indicate general trends only.



The 3% agar salt bridge demonstrated the best electrical performance, possibly due to optimal conductivity and lower internal resistance.

Figure3. Voltage and current profiles under different agar concentrations of salt bridge



Anaerobic anode conditions produced higher and more stable voltage and current compared to aerobic conditions, indicating more efficient electron transfer in the absence of oxygen.

Figure4. Voltage and current profiles under different anode conditions

CONCLUSION

- EM balls were effective in improving wastewater quality.
- Commercial EM balls showed slightly higher treatment efficiency.
- Electricity generation was successfully achieved using a microbial fuel cell system.
- Agar concentration in the salt bridge significantly affected electrical performance.
- Anaerobic anode conditions were more suitable for electricity generation.
- Further optimization is required to enhance system stability and electrical output.

ACKNOWLEDGEMENT

The authors sincerely thank the Division of Biochemistry and Biochemical Innovation for the opportunity to conduct this study. Special thanks to Ms. Yaravee for technical assistance and instrument support, as well as our friends and families for their continuous encouragement.