UJAT
Universidad Juárez Autónoma de Tabasco
"Estudio en la duda. Acción en la fe"

JEEOS

Journal of Energy, Engineering Optimization and Sustainability

2026



Vol. 10 Núm. 3 (2026)

Reserva de Derechos al Uso Exclusivo

No. 04-2026-050410175100-102. ISSN: 2448-8186

Esta revista está citada en:

Sistema Regional de Información en Línea para Revistas Científicas de América Latina y el Caribe, España y Portugal LATINDEX.http://www.1atindex.unam.mx/ JOURNAL OF ENERGY, ENGINEERING OPTIMIZATION AND SUSTAINABILITY, Vol 10, No. 3, Año 2026, es una publicación continúa editada por la Universidad Juárez Autónoma de Tabasco, Av. Universidad S/N, Zona de la Cultura, Col. Magisterial, C.P. 86040, Villahermosa, Tabasco, México. Tel. (+52) (933) 358 1500 Ext. 5040, https://revistajeeos.ujat.mx/JEEOS/es/, Email: jeeos@ujat.mx. Indizada en LATINDEX. Editora responsable: Laura Lorena Díaz Flores. Reserva de derechos al uso exclusivo No. 04-2026-050410175100-102, ISSN: 2448-8186, ambos otorgados por el Instituto Nacional del Derecho de Autor. Responsable de la última actualización de este número: Pauly González Mayo, Universidad Juárez Autónoma de Tabasco, Av. Universidad S/N, Zona de la Cultura, Col. Magisterial, Centro, Tabasco. C.P. 86040. Fecha de última actualización, 15 de diciembre 2026.

This work is licensed under a Creative Commons Attribution- NonCommercialShareAlike 4.0 International License.

Índice Vol. 10 Núm. 3 (2026)

JEEOS
UJAT
Universidad Juárez Autónoma de Tabasco
"Estudio en la duda. Acción en la fe"

Índice Vol. 10 Núm. 3 (2026)

Transformación material en la vivienda chontal, caso de estudio: Huimango, Cunduacán, Tabasco 1-12
Campos-de Dios P.C.[1*], Govea-Ek A.[1]

Inhibición de corrosión en acero API 5L-X52 mediante extracto etanólico de *Tradescantia spathacea Sw* 13-25
Estrada-Hernández G. V., Figueroa-Ramírez S.J.[*], Sierra-Grajeda J.M.T., Santis Espinosa L.F., Benavides O., De la Cruz-May L

Efecto de las nanoparticulas metálicas sobre el crecimiento de la microalga *Coelastrella sp.* para la producción de biocombustible 26-37
Santis-Espinosa L.F[1*], Figueroa-Ramírez S.J.[1], Vargas-Estrada L.[2], López-Vidaña E.C.[3]

Influence of dopant material on a silicone polymer subjected to low-pressure air plasma treatments 38-52
Alarcón-Hernández F.B.[1]*, Fuentes-Albarrán M. del C.[1], Paredes-Olguín M.[2], Avelar-Domínguez F.[1], Gadea-Pacheco J.L.[1], Sandoval-González A.[3]

Cambio en la producción de potencia empleando Na_2SO_4 en el cátodo de una celda de combustible microbiana 53-60
Fuentes-Albarrán M. del C.[1]*, Alarcón-Hernández F.B.[1], Cornejo-Tapia C.P.[1], Sandoval-González A.[2]

Estudio exploratorio del contenido de etanol en la pulpa de la T*hevetia peruviana* (Pers.) K. Schum en Yucatán, México 61-79
Koh-Echeverría L.E.[1], Amado-Méndez K.[2], Díaz-Ballote, L.F.J.[2], Herrera-Zamora, D.M.[2]*

Determinación de carbohidratos por HPLC: comparación de detectores UV-Vis *vs* índice de refracción 80-93
Fernández-Orozco I.V.[1], Grijalva-Haro M.I.[2], Madrigal-Diaz S.C.[1], Ojeda-Morales M.E.[1], Díaz-Reyes C.C.[1], García-López S.[1], Juárez-Zirate S.J.[3]*

Efecto de un plasma pulsado de aire en las propiedades superficiales de caucho butílico 94-103
Alarcón-Hernández F.B.[1]*, Fuentes-Albarrán M. del C.[1], Garay-Galicia J.A.[1], Sandoval-Gonzáles A.[2]

Estudio del tiempo de fraguado en pastas de cemento con sustitución parcial por biocemento de ostión 104-116
Segundo-Díaz T. de J.[1], Mora-Ortiz R.S.[1]*, Díaz-Alvarado S.A.[1], Ramón-de los Santos C. [2]

Estudio teórico de un captador solar de aire con y sin material de cambio de fase 117-128
Álvarez-Alor B.[1*], Cruz-Valdez J. A. [2], Montalvo D. [3], López-Santos F.[1], Alvarado-Méndez P. E.[4], Zetina-Ríos I. I.[5].

Cambio en la producción de potencia empleando Na_2SO_4 en el cátodo de una celda de combustible microbiana

Change in power production using Na_2SO_4 in the cathode of a microbial fuel cell

Fuentes-Albarrán M. del C.[1]*, Alarcón-Hernández F.B.[1], Cornejo-Tapia C.P.[1], Sandoval-González A.[2]

[1]Escuela de Estudios Superiores de Xalostoc de la Universidad Autónoma del Estado de Morelos
Avenida Nicolas Bravo s/n, Xalostoc CP 62725 Ayala, Morelos, México.
[2]Centro de Investigación y Desarrollo Tecnológico en Electroquímica, S.C
Parque Tecnológico Querétaro SN, CP 76703 San Fandila, Querétaro, México.
*carmen.fuentes@uaem.mx

Artículo Científico
Publicado: 15 de diciembre 2026

ABSTRACT

The power output of a microbial fuel cell was examined by varying the catholyte conditions. During acclimation, tap water served as catholyte, yielding a stable voltage of 0.55 ± 0.07 V after 8 days. Subsequently, Na_2SO_4 concentrations (0.3 and 0.5 M) were tested. Cell performance was evaluated using polarization and power curves. The lowest potential losses and highest power output occurred at 0.3 M Na_2SO_4. Peak power was 37.41 mW/m² with a current density of 101.94 mA/m². This result shows that conductivity affects the optimization of these systems for electricity production.
Keywords: Conductivity; internal resistance, power density; wastewater.

INTRODUCTION

Global energy demand is rising, and fossil fuels are used to meet these needs, driving emissions that contribute to climate change [1]. Renewable energies have gained significant momentum as clean energy resources [2]. Microbial fuel cells (MFCs) are an attractive alternative for electricity, converting organic waste into power [3,4]. Wastewater is an ideal fuel in these systems, offering both biological treatment and electricity production [5,6].

An MFC typically consists of an anodic and a cathodic chamber, separated by a proton exchange membrane [7,8]. At the anode, microorganisms degrade organic matter, generating electrons and protons. The protons pass through a membrane to the cathode, while the electrons flow to the cathode through an external electrical connection that usually includes a resistor. At the cathode, electrons, protons, and oxygen combine to form water [9,10]. However, despite its advantages, power output in MFCs remains low. A wide range of factors affect the performance and energy generation efficiency of this technology. These include electrode materials, microbial populations, pH, substrate concentrations, and conductivity [11,12].

EXPERIMENTAL METHODOLOGY

Registro ISSN 2448-8186
DOI:10.19136/Jeeos.a10n3.6693

MFC Configuration. In the experiment, a type H MFC was used, consisting of two cylindrical glass compartments with a volume of 226.20 cm³ each (Figure 1). A Nafion® 117 proton exchange membrane was used to separate the two compartments, with gaskets placed between the junctions to prevent leaks. Carbon fiber electrodes (Fibre Glast Developments Corporation) were used. An uncatalyzed electrode was used at the anode, and a Pt/C (0.4 mg/cm²) catalyst was used at the cathode. Both electrodes had an area of 0.0018 m². The system was maintained at room temperature.

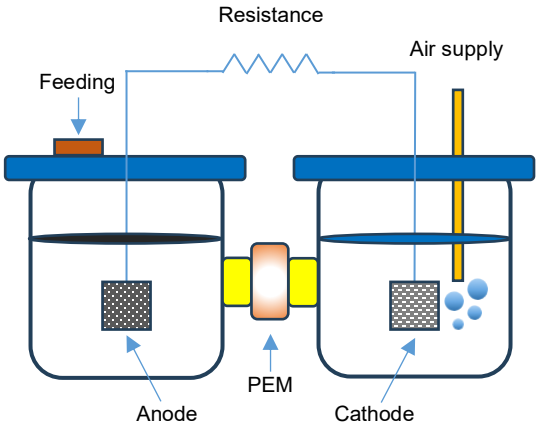


Figure 1. Experimental schematic of the microbial fuel cell.

Anolyte. A microbial consortium derived from domestic wastewater was used in the anolyte, employing acetate as a substrate (0.003 mol L^{-1}) and a buffer solution (NH_4Cl 0.31 gL^{-1}, KCl 0.31 gL^{-1}, $NaH_2PO_4 \cdot 2H_2O$ 3.32 g L^{-1}, $Na_2HPO_4 \cdot 2H_2O$ 10.32 gL^{-1}). This compartment was maintained under anaerobic conditions.

Catolyte. Tap water was used in the catholyte during the cell acclimation stage. Subsequently, once the system was stable, the conductivity was varied by changing Na_2SO_4 concentration (0.3 and 0.5 M). This compartment was maintained under aerobic conditions, supplied with air using an aquarium pump.

Data Acquisition and System Characterization. During the MFC acclimation phase, the open-circuit voltage (OCV) was monitored with a multimeter (Steren Professional Deluxe Multimeter with PC interface, Model: MUL-600). Once the cell reached a stable voltage, power output was evaluated by varying the system's conductivity. The MFC was characterized by using polarization and power curves, employing an external variable resistor (R_{Ext}) ranging from 5 to 10 kΩ. The resulting voltage was recorded for each resistance setting, and the current was determined using Ohm's Law:

$$I = E_{MFC}/R_{Ext}$$

Where: I is the current, E_{MFC} is the cell voltage, and R_{Ext} is the external resistance.

Registro ISSN 2448-8186
DOI:10.19136/Jeeos.a10n3.6693

The polarization curve was obtained by plotting voltage versus current, normalized to the anode area (m²). The power density curve was obtained by plotting power density versus current density, determining the power output (P_{MFC}) as follows:

$$P_{MFC} = {E^2_{MFC}}/{R_{Ext}}$$

Internal resistance. The internal resistance of the system was determined from the obtained bias curves, using the following expression:

$$E_{MFC} = E_b - IR_{Int}$$

Where: E_b is the extrapolation of the linear (intermediate) portion of a bias curve, I is the current, and R_{Int} is the internal resistance

RESULTS

The cell acclimation results, as well as the polarization and power graphs, are shown below.

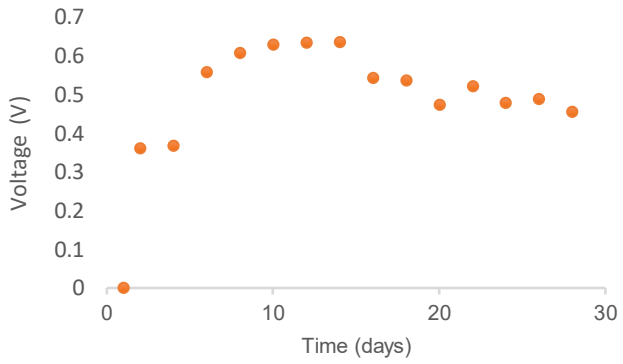


Figure 2. Acclimation stage of the MFC. Catholyte: Water.

Acclimation. Figure 2 shows the acclimation curve of the MFC. The system was in operation for 28 days. During the first 7 days of operation, the voltage gradually increased to ~0.57 V. Subsequently, the system stabilized at 0.55 ± 0.07 V, suggesting that the cell anode had been colonized by microorganisms.

Once the system reached stability, the MFC's power output performance was evaluated by varying the catholyte conductivity.

Characterization of the microbial fuel cell. Figure 3 shows the polarization curves obtained for the different concentrations of Na_2SO_4 used. As can be seen in the graph, the open-circuit voltage (OCV) using water as the catholyte was 0.62 V, while for 0.3 and 0.5 M it remained constant at ~0.8 V. When using water and 0.5 M Na_2SO_4 as the catholyte, voltage losses were almost linear at current densities below 40 mA/m², while at higher current densities, potential losses were slower.

Registro ISSN 2448-8186
DOI:10.19136/Jeeos.a10n3.6693

For a concentration of 0.3 M Na_2SO_4, lower potential losses were observed with a decreasing linear trend. Ohmic losses occur in the intermediate region of a polarization curve, and this is the region of interest in the design of an MFC. Reducing these potential losses is crucial for better system performance in electricity generation.

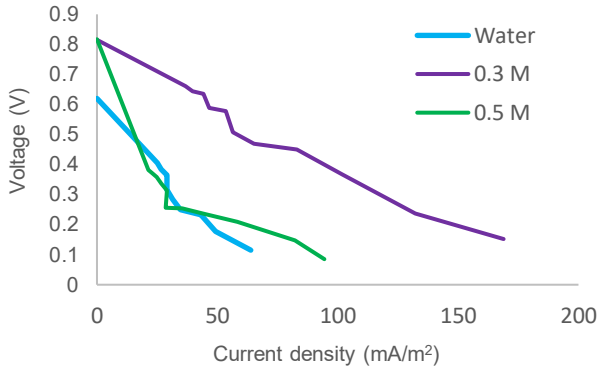


Figure 3. Polarization curves. Catholyte: Water, Na_2SO_4 (0.3 and 0.5 M).

Figure 4 shows the power output obtained in the MFC. Using water and 0.5 M Na_2SO_4 as the catholyte, peak power outputs of 10.05 and 12.16 mW/m² were generated, respectively. Power and current output increased when using 0.3 M Na_2SO_4, yielding a peak power output of 37.41 mW/m² with a current density of 101.94 mA/m².

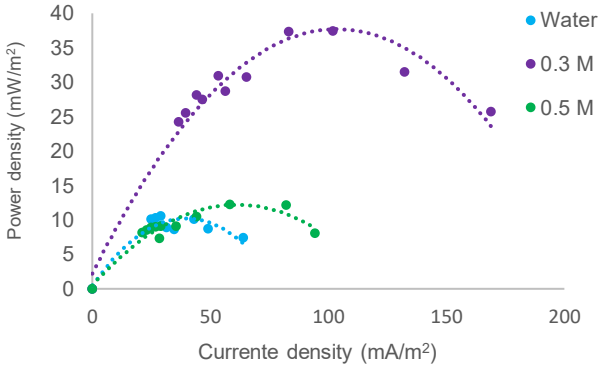


Figure 4. MFC Power Output, Catholyte: Water, Na_2SO_4 (0.3 and 0.5 M).

The concentration of Na_2SO_4 in the catholyte affects the system's conductivity and, therefore, the MFC's power output. This is an important factor to consider in the performance of these systems.

Internal Resistance. Table 1 shows the results obtained for the internal resistance of the MFC, as well as the maximum power densities obtained under each experimental condition.

Table 1. Internal resistance of the MFC and maximum power output obtained.

Registro ISSN 2448-8186
DOI:10.19136/Jeeos.a10n3.6693

Catolito	R_{int} (Ω)	Maximum power density (mW/m^2)
Water	3315	10.05
0.3 M Na_2SO_4	2111	37.41
0.5 M Na_2SO_4	1158	12.16

Adding Na_2SO_4 decreases the internal resistance. However, this behavior is not reflected in power output, as the maximum value was recorded at 0.3 M. Increasing the concentration to 0.5 M was detrimental to power output.

DISCUSSION

MFCs constitute an alternative to anaerobic digestion for obtaining energy from organic waste [13]. In these systems, microorganisms form a biofilm on the anode, transferring the electrons generated during their metabolism as they degrade organic matter. The time to microbial colonization depends on various factors, including the type of microbial culture, the system architecture, the substrate, and external resistance [14]. In this study, the colonization time was approximately 8 days, similar to that obtained in other studies. In one investigation using domestic wastewater from a brewery in MFC devices [15], a stable voltage of 0.362 ± 0.008 V was obtained after approximately 10 days of operation using a 1 kΩ resistor. Furthermore, in another study [16], different types of wastewater from the sugar, brewing, dairy, and leather industries were used. All MFCs reached their maximum voltage, between 1.0 and 1.2 V, after 8 days of operation. Wastewater contains a wide variety of microorganisms and can be efficiently used in an MFC for treatment while simultaneously producing electricity.

Conductivity is an operational factor that influences the efficiency of an MFC. Low proton conductivity restricts proton transport from the anode to the cathode, resulting in high internal resistance [17]. Internal resistance includes the electrode material's resistance, the electrolyte's conductivity, and the resistance of microbial biofilms. Reducing internal resistance can increase energy production [20].

In a previous study [18], the effect of different NaCl concentrations on the anode of an MFC was evaluated. The results showed that the highest power output was obtained at a NaCl concentration of 20 g L^{-1} (35 ± 2 Wm^{-3}), while increasing the concentration to 40 g L^{-1} reduced power output by approximately 50%. Furthermore, another study [19] analyzed the effect of conductivity on a sediment microbial fuel cell using different concentrations of NaCl and KCl. The authors observed that increasing the electrolyte conductivity improved the MFC's performance and reduced internal resistance, achieving maximum power densities of 32.76 mWm^{-2} for NaCl and 28.79 mWm^{-2} for KCl. These values are close to those obtained in this study using Na_2SO_4 as the catholyte in an MFC.

CONCLUSION

CC BY NC SA
Registro ISSN 2448-8186
DOI:10.19136/Jeeos.a10n3.6693

Microbial fuel cells (MFCs) represent a viable alternative for producing electricity from organic waste. Electrolyte conductivity is a factor that influences MFC performance and is related to the system's internal resistance. Hence, the importance of optimizing operating conditions to maximize MFC performance for practical applications.

ACKNOWLEDGMENTS

The authors are grateful to Escuela de Estudios Superiores de Xalostoc of Universidad Autónoma del Estado de Morelos, for the facilities provided to carry out this research. This work was funded by PRODEP [DSA/103.5/14/10703].

REFERENCES

[1] A. Raihan, M. S. A. Joarder, S. M. Rahman, A. M. Bari, M. Ridwan y T. Sarker, "Renewable energy resources for green development in Bangladesh: Perspectives, challenges, and opportunities," Innov. Green Dev., vol. 4, no. 5, Art. no. 100298, 2025, doi: 10.1016/j.igd.2025.100298.

[2] J. A. Afolabi, "Towards carbon neutrality in Europe: The role of technology exports, renewable energy consumption, and resource productivity," J. Environ. Manage., vol. 395, Art. no. 127862, 2025, doi: 10.1016/j.jenvman.2025.127862.

[3] J. Vilas Boas, V. B. Oliveira, M. Simões y A. M. F. R. Pinto, "Review on microbial fuel cells applications, developments and costs," J. Environ. Manage., vol. 307, Art. no. 114525, 2022, doi: 10.1016/j.jenvman.2022.114525.

[4] D. Bose, R. Bhattacharya, M. Pillai, A. Ray, T. Kaur, S. Mondal y A. Mondal, "State-of-the-art review on sediment microbial fuel cells: Evolution, innovations, challenges, scalability, and policy implications for sustainable development," Water-Energy Nexus, vol. 9, 2025, doi: 10.1016/j.wen.2025.12.005.

[5] S. Sikder y M. M. Rahman, "Efficiency of microbial fuel cell in wastewater (municipal, textile, and tannery) treatment and bioelectricity production," Case Stud. Chem. Environ. Eng., vol. 8, Art. no. 100421, 2023, doi: 10.1016/j.cscee.2023.100421.

[6] H. Du y Z. Shao, "Advances in anodes of microbial fuel cells for wastewater remediation and power generation," Mater. Rep. Energy, vol. 5, no. 4, Art. no. 100373, 2025, doi: 10.1016/j.matre.2025.100373.

[7] R. Suresh, S. Rajendran, P. S. Kumar, K. Dutta y D.-V. N. Vo, "RETRACTED: Current advances in microbial fuel cell technology toward removal of organic contaminants - A review," Chemosphere, vol. 287, Part 2, Art. no. 132186, 2022, doi: 10.1016/j.chemosphere.2021.132186.

[8] N. Bazina, T. G. Ahmed, M. Almdaaf, S. Jibia y M. Sarker, "Power generation from wastewater using microbial fuel cells: A review," J. Biotechnol., vol. 374, pp. 17–30, 2023, doi: 10.1016/j.jbiotec.2023.07.006.

CC BY NC SA

Registro ISSN 2448-8186
DOI:10.19136/Jeeos.a10n3.6693

[9] D. R. Lovley, "Bug juice: Harvesting electricity with microorganisms," Nat. Rev. Microbiol., vol. 4, pp. 497–508, 22006, doi 10.1038/nrmicro1442.

[10] K. Rabaey y W. Verstraete, "Microbial fuel cells: Novel biotechnology for energy generation," Trends Biotechnol., vol. 23, no. 6, pp. 291–298, 2005.

[11] S. S. Kumar, V. Kumar, R. Kumar, S. K. Malyan y A. Pugazhendhi, "Microbial fuel cells as a sustainable platform technology for bioenergy, biosensing, environmental monitoring, and other low power device applications," Fuel, vol. 255, Art. no. 115682, 2019, doi: 10.1016/j.fuel.2019.115682.

[12] N. Hossain, M. S. Islam, M. K. Rahman, M. J. Talukder, M. R. Chowdhury, J. J. Mim, S. Islam, S. M. M. Rahman y M. M. R. Arup, "Microbial fuel cells: Bright sparks and lingering shadows: A comprehensive review," Sustain. Chem. Climate Action, vol. 7, Art. no. 100156, 2025, doi: 10.1016/j.scca.2025.100156.

[13] N. S. Malvankar, J. Lau, K. P. Nevin, A. E. Franks, M. T. Tuominen y D. R. Lovley, "Electrical conductivity in a mixed-species biofilm," Appl. Environ. Microbiol., vol. 78, no. 16, pp. 5967–5971, 2012.

[14] H. Du y Z. Shao, "Advances in anodes of microbial fuel cells for wastewater remediation and power generation," Mater. Rep. Energy, vol. 5, Art. no. 100373, 2025, doi: 10.1016/j.matre.2025.100373.

[15] Y. Feng, X. Wang, B. E. Logan y H. Lee, "Brewery wastewater treatment using air-cathode microbial fuel cells," Appl. Microbiol. Biotechnol., vol. 78, pp. 873–880, 2008, doi: 10.1007/s00253-008-1360-2.

[16] O. Sahu, "Assessment of sugarcane industry: Suitability for production, consumption, and utilization," Ann. Agrar. Sci., vol. 16, no. 4, pp. 389–395, 2018, doi: 10.1016/j.aasci.2018.08.001.

[17] B. Kanani, A. Zahedi, F. Abtahi y S. Abedi, "Exploring operational barriers in microbial fuel cells: Enhancing energy recovery from wastewater," Electrochem. Commun., vol. 180, Art. no. 108051, 2025, doi: 10.1016/j.elecom.2025.108051.

[18] O. Lefebvre, Z. Tan, S. Kharkwal y H. Y. Ng, "Effect of increasing anodic NaCl concentration on microbial fuel cell performance," Bioresour. Technol., vol. 112, pp. 336–340, 2012, doi: 10.1016/j.biortech.2012.02.048.

[19] Z. Najafgholi, M. Rahimnejad y G. Najafpour, "Effect of electrolyte conductivity and aeration on performance of sediment microbial fuel cell," J. Renew. Energy Environ., vol. 2, no. 1, pp. 43–48, 2015.

[20] N. Hossain, M. S. Islam, M. K. Rahman, M. J. Talukder, M. R. Chowdhury, J. J. Mim, S. Islam, S. M. M. Rahman y M. M. Rahman Arup, "Microbial fuel cells: Bright sparks and lingering shadows: A comprehensive review," Sustain. Chem. Climate Action, vol. 7, Art. no. 100156, 2025, doi: 10.1016/j.scca.2025.100156.

Registro ISSN 2448-8186
DOI:10.19136/Jeeos.a10n3.6693

Registro ISSN 2448-8186
DOI:10.19136/Jeeos.a10n3.6693