Microbial Fuel Cells

Current density generation using multiple substrates.

Sonal Bhargava, Shoutao Xu, Dr. Hong Liu

Objective

- Effect on the performance of Microbial Fuel Cell using different enrichment medium.

Introduction

- Microbial fuel cell is a system that drives a current to generate electricity using bacteria found in nature.
- Microbial fuel cell uses various organisms, substrates and wastewaters to produce or harvest electricity.
- There are two main components of the fuel cell: cathode and anode compartments along with a cation specific membrane.
- In the anode compartment, microorganisms oxidize substrates which generate electrons and protons. Electrons are then transferred to the cathode compartment through an external electric circuit. Protons are transferred to the cathode compartment through the cation specific membrane. Consumption of electrons and protons in the cathode compartment with oxygen results in formation of water.

Method

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Electron Acceptor</th>
<th>Carbon Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified Geobacter Medium 1 (MGM)</td>
<td>Oxygen</td>
<td>Sodium Acetate</td>
</tr>
<tr>
<td>MGM 2</td>
<td>Ferric</td>
<td>Sodium Acetate</td>
</tr>
<tr>
<td>MGM 3</td>
<td>Nitrate</td>
<td>Sodium Acetate</td>
</tr>
<tr>
<td>Leuria-Bertani (LB)</td>
<td>Oxygen</td>
<td>Yeast extract</td>
</tr>
<tr>
<td>Geobacter Medium</td>
<td>Ferric</td>
<td>Sodium acetate</td>
</tr>
</tbody>
</table>

- Inoculate mix culture into each of the five mediums
- Enrich the bacteria and transfer the solution every day depending on the growth of the bacteria for one month
- After one month, add the bacteria along with a solution of MGM into the MFC
- Change the solution in MFC every other day
- Test for current generation
- All the data for a month was collected and recorded in the Multimeter Data Logger (KEITHLEY, USA)
- Data points measured voltage over a 1000 Ω resistor

Results

- Current density (mA/m²) measurements were used to analyze the data
- Geobacter medium was the best substrate as it produced the highest value for current density of 7.750 mA/m².
- MGM+nitrate had the lowest current density with the value of 2.089 mA/m²

<table>
<thead>
<tr>
<th>Substrates</th>
<th>Average Current Density (mA/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geobacter Medium</td>
<td>7.750</td>
</tr>
<tr>
<td>MGM+ferric</td>
<td>3.270</td>
</tr>
<tr>
<td>MGM</td>
<td>2.980</td>
</tr>
<tr>
<td>LB</td>
<td>2.140</td>
</tr>
<tr>
<td>MGM+nitrate</td>
<td>2.090</td>
</tr>
</tbody>
</table>

Table 2: Average current density of five substrates tested

Conclusion

- Geobacter medium produced the highest current density of 7.750 mA/m² over a month
- Mix culture enriched with Ferric such as Geobacter medium and MGM+ferric tend to be better electron acceptor than non ferric based solutions and produce higher current density
- Previous studies indicate that when a MFC is enriched by a mix culture, current density values of 10A/m² can be observed. (American Society for Microbiology)
- This was not the case for our experiment as we got lower numbers than what was expected.

Future Work

- To improve the results more than one batch should be run so the bacteria can use the electrodes and can adjust to the environment.
- Different enrichment methods should also be explored.
- Bacterial community analysis can also be conducted to test for which species are present in the solution.

Acknowledgements

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