Usage of Microbial Fuel Cell Technology to Prevent Iron Release nearby Landfills in Northwest Florida

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Iron Release in NW Florida

Central Landfill
Walton County

Fairgrounds Branch below
Auto Shred Landfill

Visible Iron Release nearby Landfills

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Roles of Microorganisms in Iron Release

Coffee Creek
Beulah Landfill

NW Florida Iron Rich Soil

Iron Reducing Bacteria and Iron Rich Soil

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- Landfill leachate treatment
- Iron release prevention
- Energy generation

Landfills at Isolated Locations

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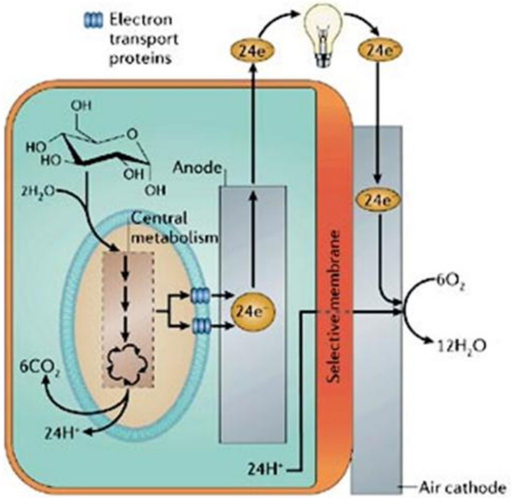
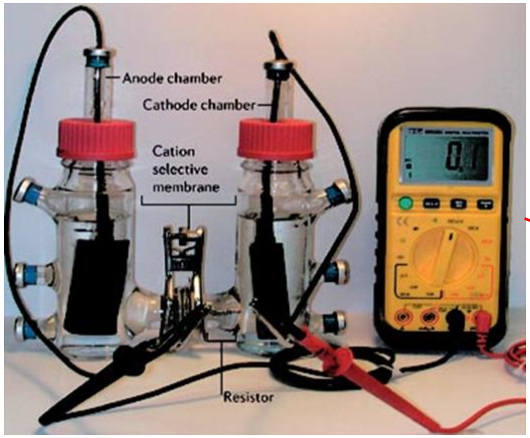
Electricity Generation



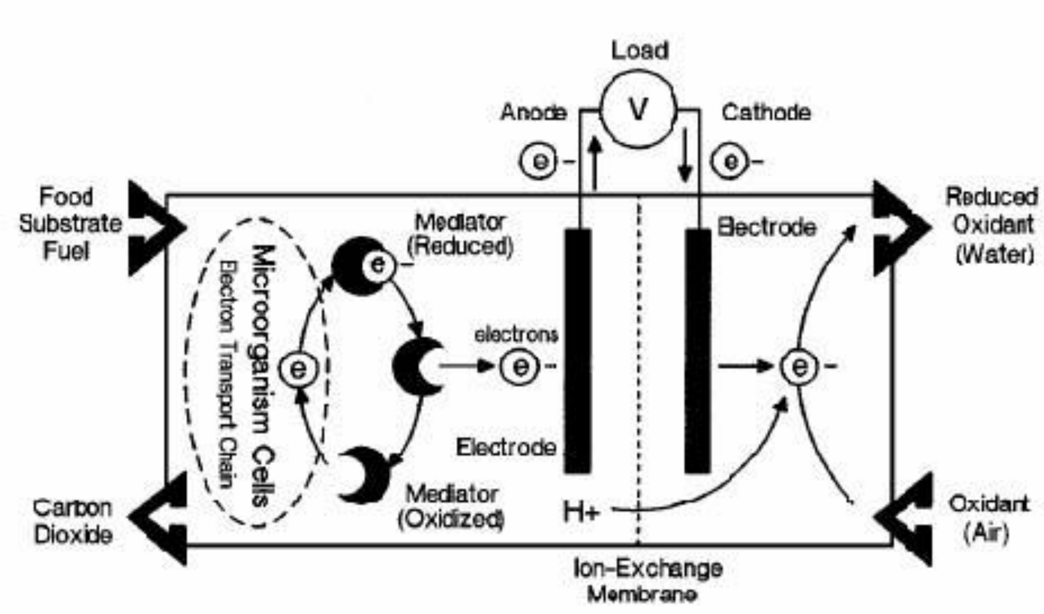
Electron consumption separated from organic carbon oxidation

- ➢ Landfill leachate decomposition
- ➢ Ferrous iron release prevention

Electricity Generation

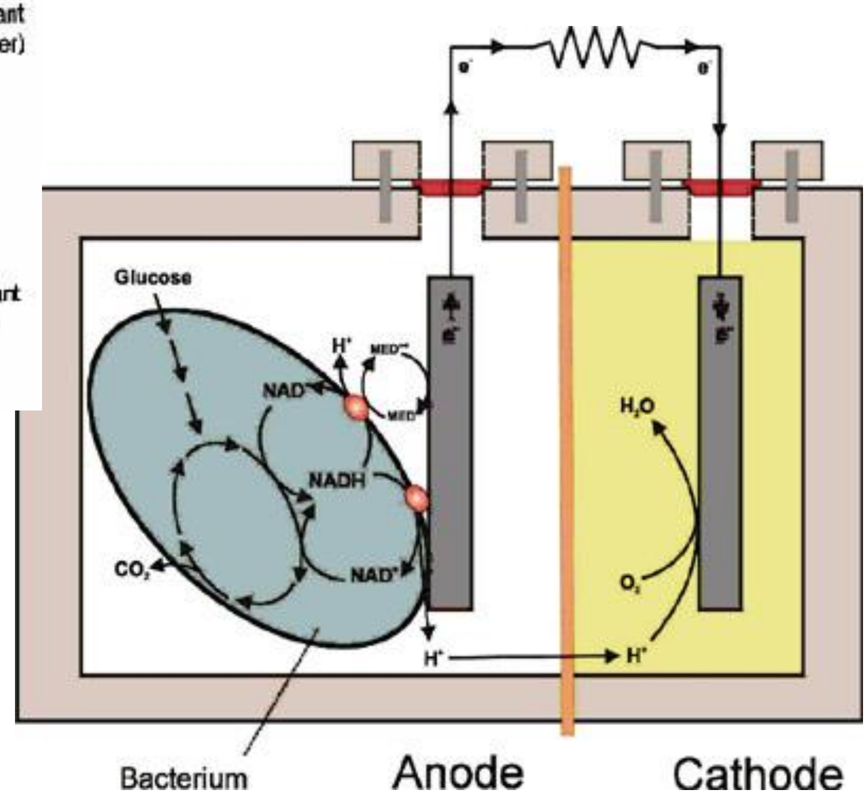


- ➢ Green energy



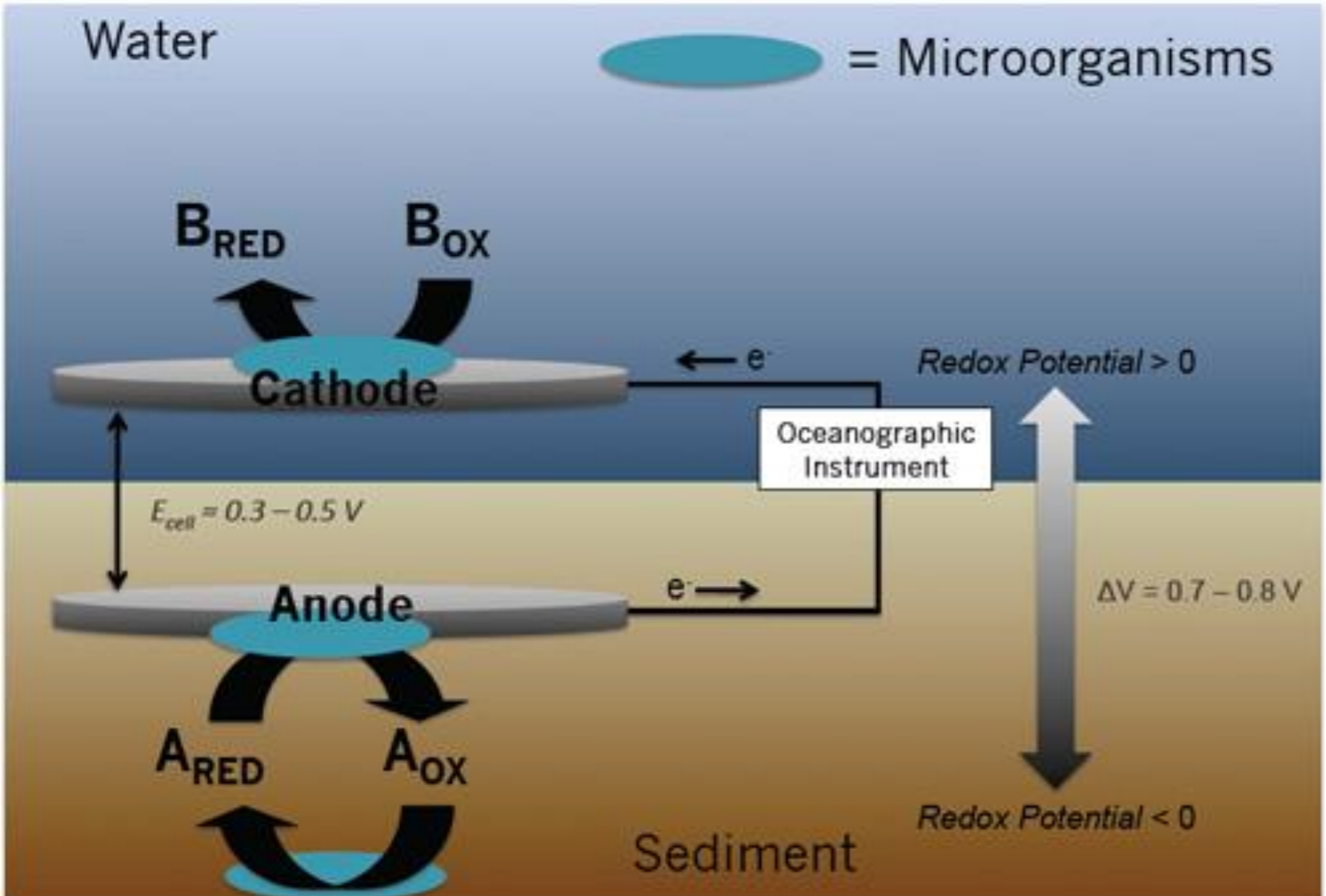
Mediator-Facilitated MFC

Mediator-Less MFC



Electron Transfer in a MFC

Benthic Unattended Generators



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Objectives

- **Landfill leachate collection and *Shewanella putrefaciens* culturing**
- **Laboratory scale MFC experiments**
  - Landfill leachate decomposition
  - Electricity generation
- **Pilot scale MFC experiments**
  - Landfill leachate decomposion
  - Electricity generation
  - Ferrous iron release prevention

Landfill Soil and Leachate Collection

Leachate was collected from a tank, using a bailer at Franklin County Central Landfill. The leachate tank is located near Monitoring Well MW-19.

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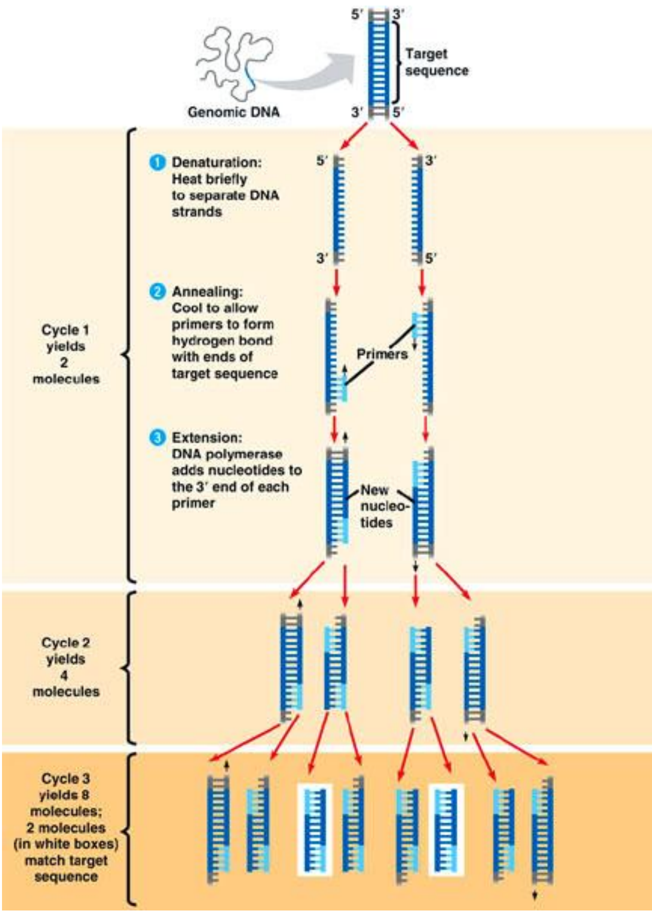
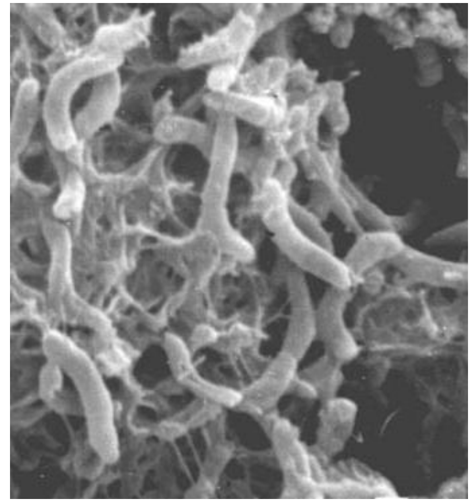
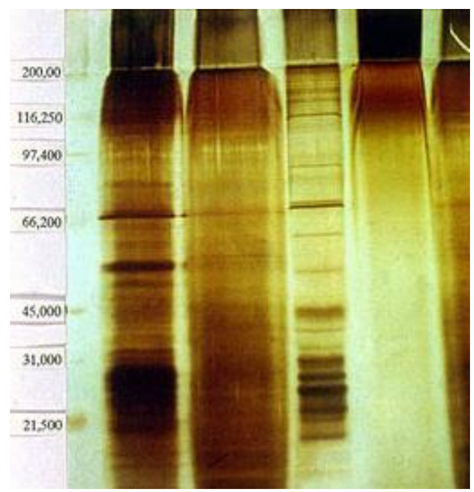
Shewanella putrefaciens Culturing



polymerase chain reaction





Culturing Media

- KH_2PO_4 160 mg/l
- K_2HPO_4 420 mg/l
- Na_2HPO_4 50 mg/l
- NH_4Cl 40 mg/l
- $MgSO_4 \cdot 7H_2O$ 50 mg/l
- $CaCl_2$ 50 mg/l
- $FeCl_3 \cdot 6H_2O$ 0.5 mg/l
- $MnSO_4 \cdot 4H_2O$ 0.05 mg/l
- H_3BO_3 0.1 mg/l
- $ZnSO_4 \cdot 7H_2O$ 0.05 mg/l
- $(NH4)_6Mo_7O_{24}$ 0.03 mg/l
- Glucose 200 mg/l

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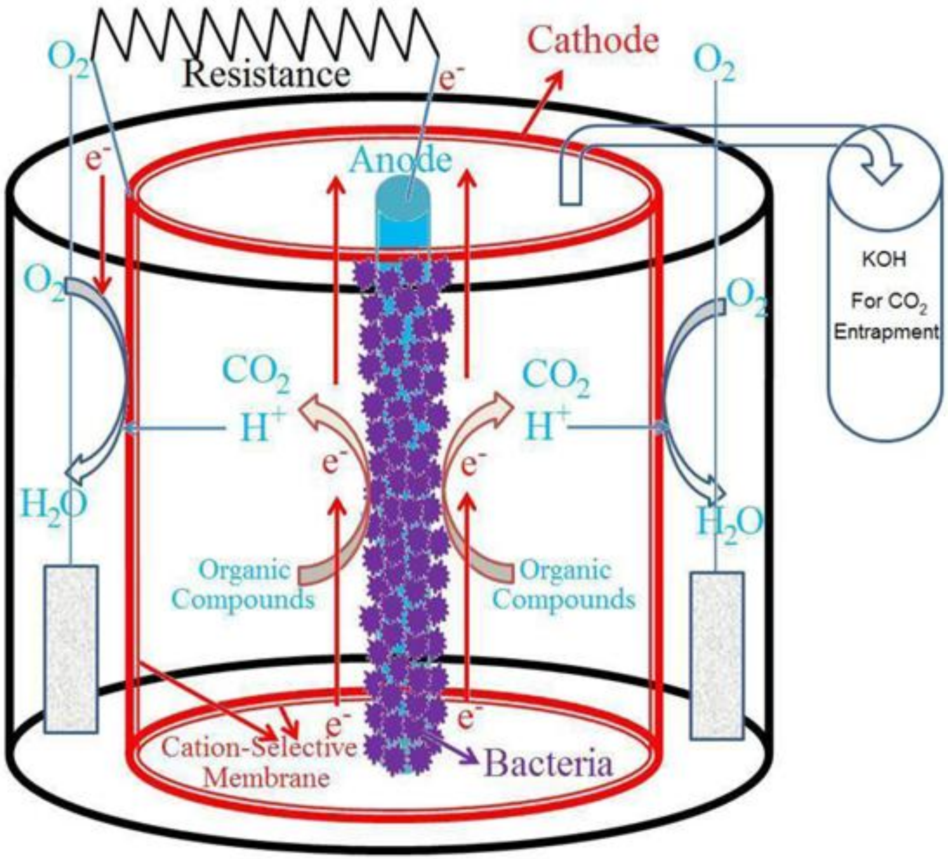
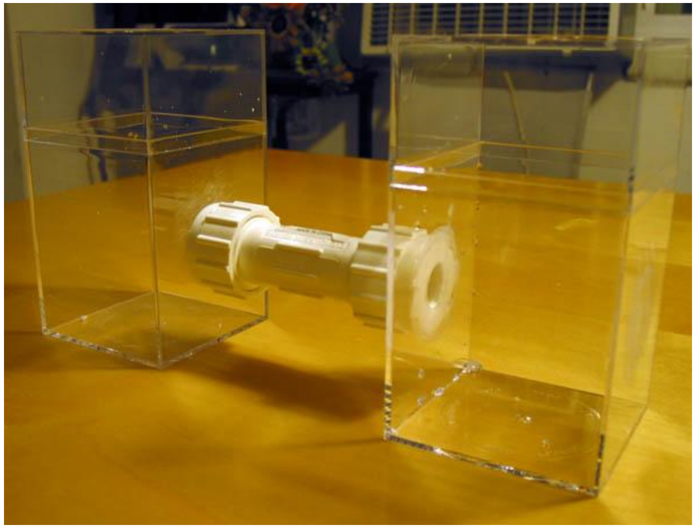
Laboratory MFC Setup





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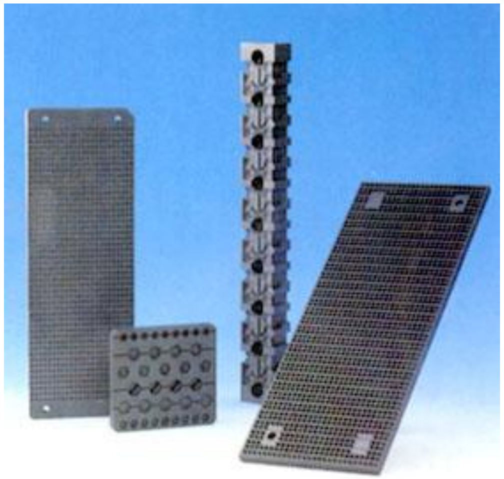
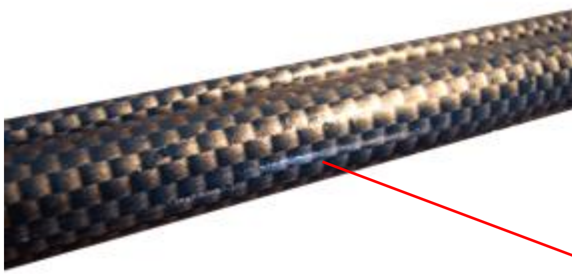
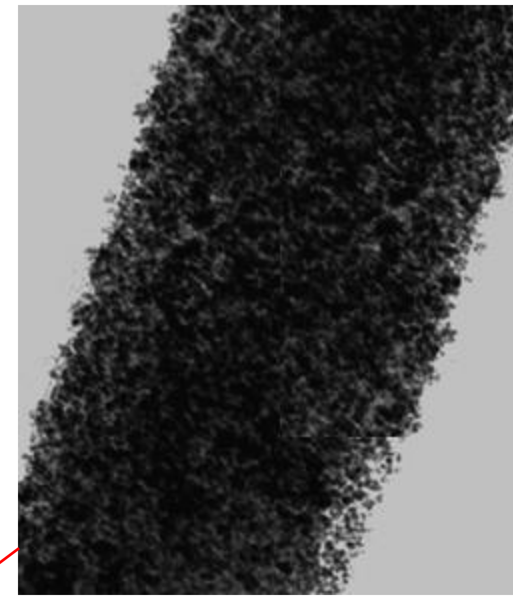
Anode Selection



Carbon Graphite Plate

Carbon Graphite Rod

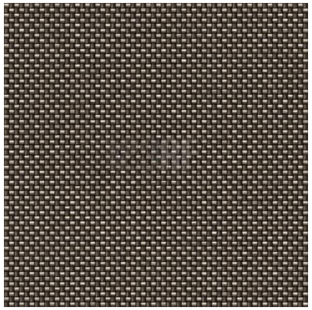




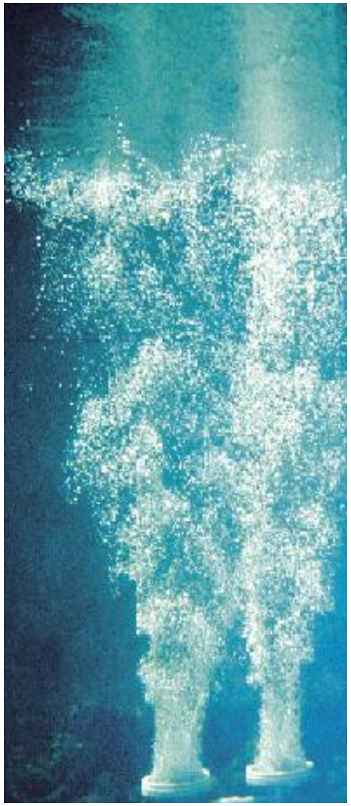
Conventional (woven) graphite rod VS. highly porous graphite rod

Electron Acceptor Selection

Advantage of Potassium Ferricyanide



- Low over potential using a plain carbon cathode
- Cathode working potential close to its open circuit potential
- 50 - 80% increase in maximum power generation
- No need for expensive platinum as the catalyst



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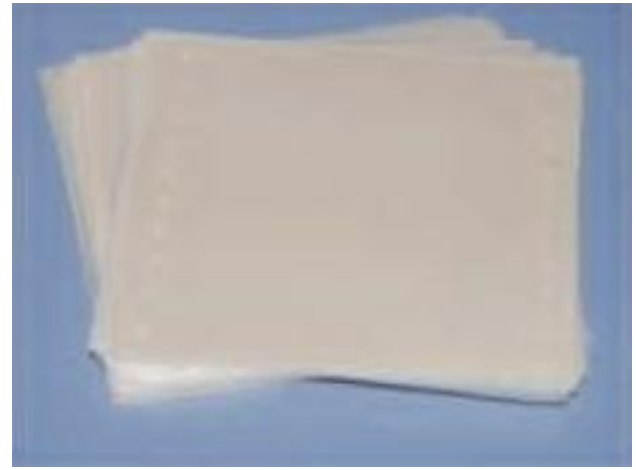
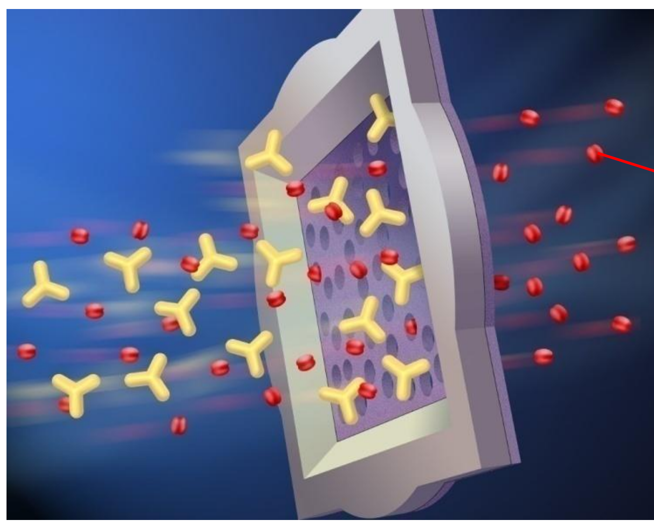
Membrane

Nafion



Ultrex CMI-7000



Proton

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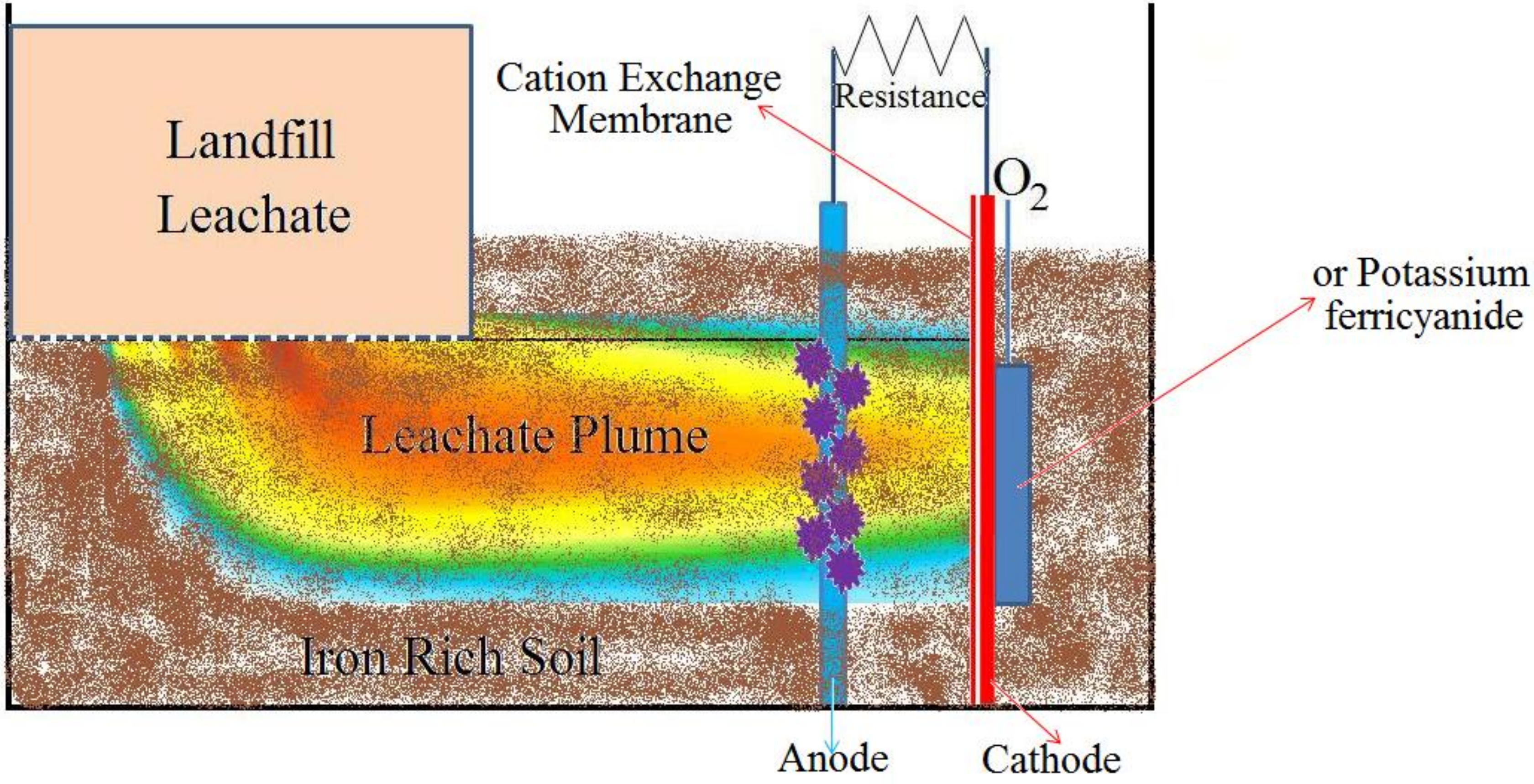
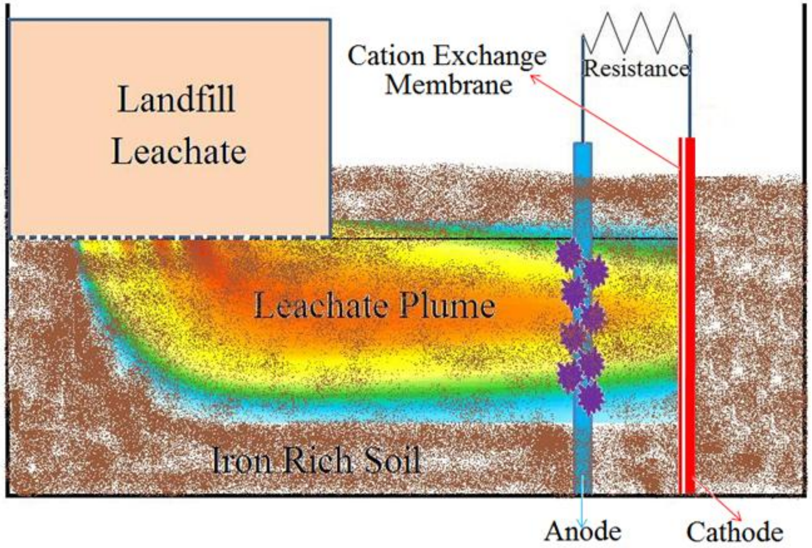
Pilot MCF Experiments

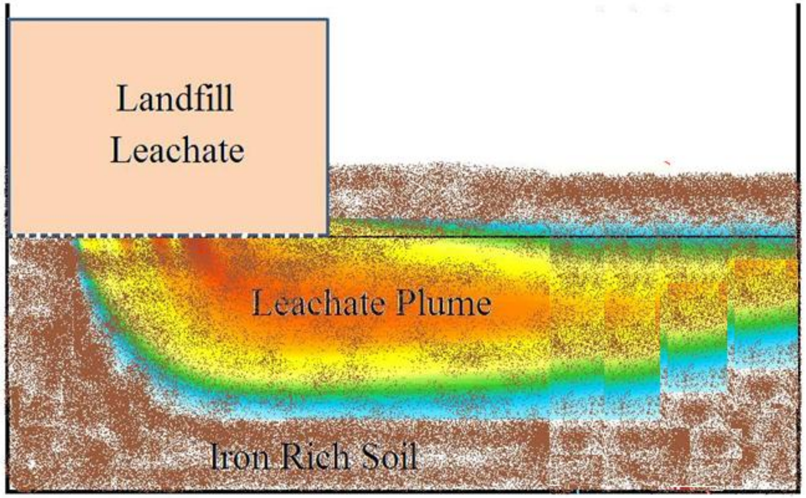


Pilot MCF Experiments

Parallel Control Experiments



No Electron Acceptor Provided



Cathode and Anode Removed

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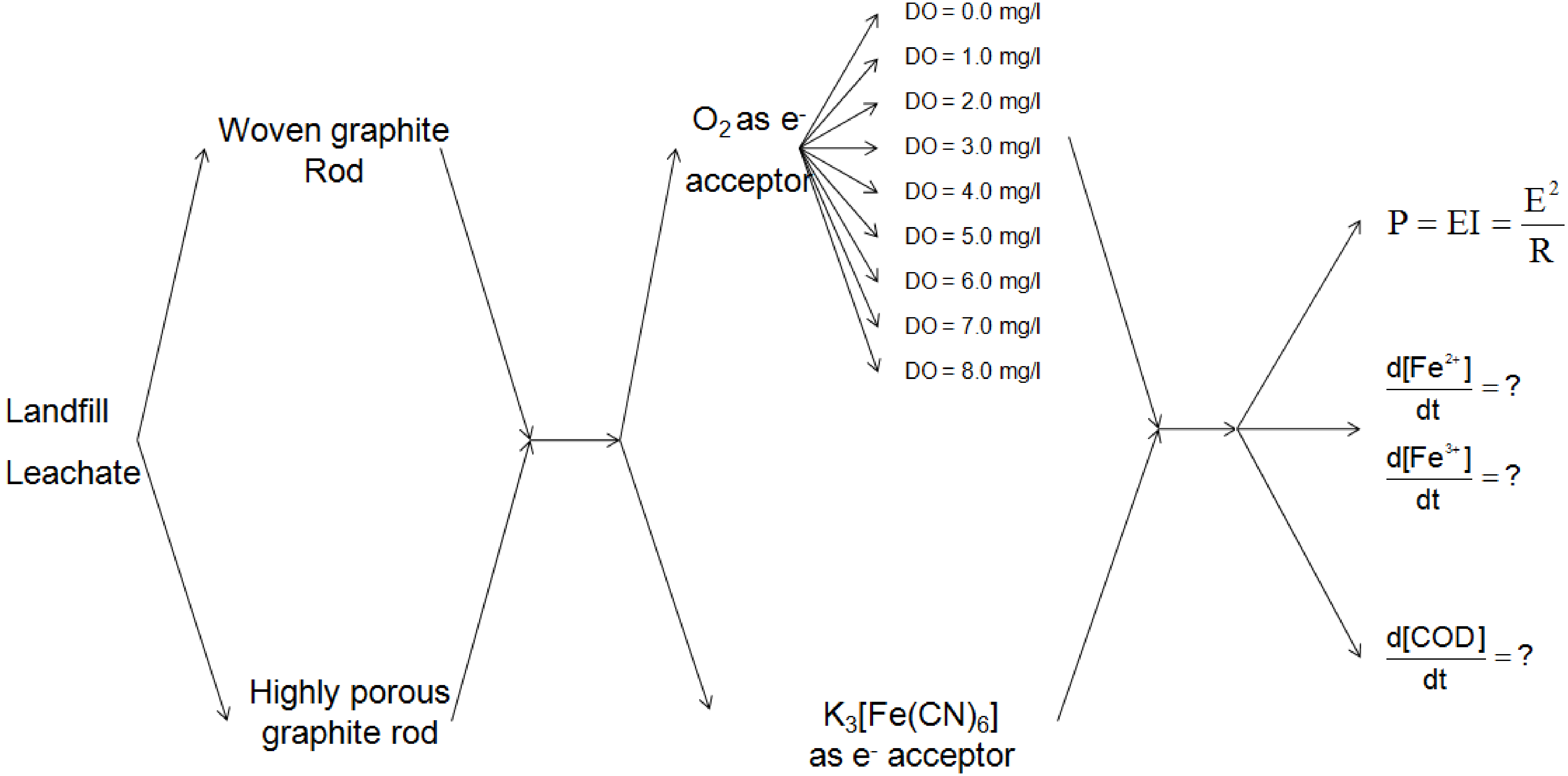
Expected Results



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Power Generation

Current and Power

$$I = \frac{E}{R} \qquad P = EI = \frac{E^2}{R}$$

I: current expressed in amperes (A)

E: cell voltage expressed in volts (V)

R: electrical resistance expressed in ohms (Ω)

P: power output expressed in watts (W)

Oxygen as Electron Acceptor

$$P = \frac{P_{max} DO}{K_{DO} + DO}$$

P_{max}: maximum power generation

K_{DO}: half-saturation constant, which is also the indicator of the concentration of DO that produces a power density one-half of the maximum values

A nonlinear regression to be used to simulate the results to obtain the K_{DO} value

Primary Results

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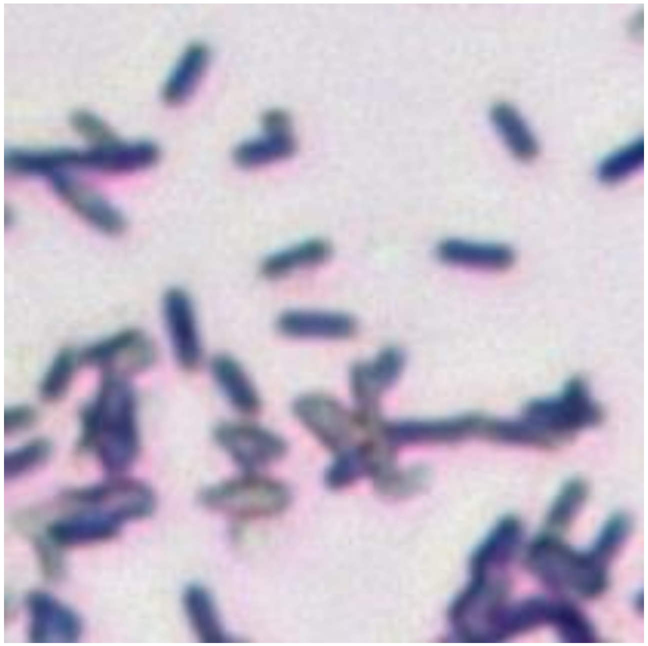
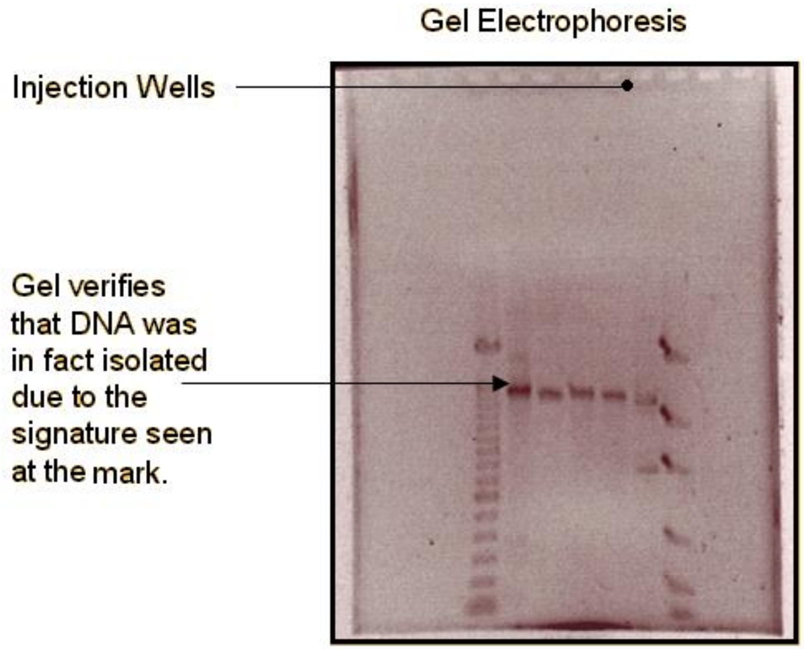
Primary Results





Shewanella putrefaciens **Microscopy Images (Left) and PCR Identification (Right)**

Questions?

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