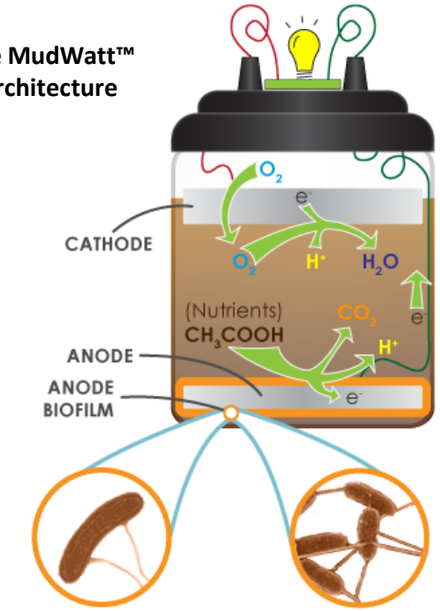
Microbial fuel cells (MFCs) are bio-electrical devices that harness the natural metabolisms of microbes to produce electrical power. Within the MFC, microbes munch up the sugars and other nutrients in their surrounding environment and release a portion of the energy contained within that food in the form of electricity.

Microbes thrive throughout nearly all soils and sediments on the planet. Among these thriving communities of microbes are particular species with unique metabolic abilities that enable them to release electrons onto metal compounds, such as rust. In a sense, these so-called "electrogenic" (or electricity-generating) microbes are able to "breathe" metal compounds much like humans and other animals breathe oxygen. The MudWatt™ takes advantage of this unique ability with a certain configuration of two inert, carbon-based electrodes , as shown on the next page.

Educators: For more educational material, please visit our Community page at www.keegotech.com/community.

The MudWatt™ Architecture



Soils are naturally teaming with a diverse consortium of microbes, including the electrogenic species needed for MFCs, so the MudWatt™ doesn't require any additional microbes. Also, mud is full of complex sugars and other nutrients that have accumulated over millions of years of plant and animal decay, so there is plenty of food for the microbes to thrive for years. There are two species of electrogenic microbes in particular (shown on the next page) that are commonly found in MFCs.

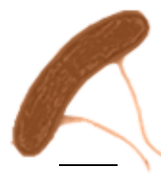
Within the MudWatt™, the Anode is buried within mud, while the Cathode rests on top. In this configuration, a biofilm containing billions of microbes will develop on the anode surface over time. As this biofilm forms, it will munch up the sugars and nutrients in the mud, generating highly reduced biomolecules (i.e. biomolecules with extra electrons attached to them) as waste. These biomolecules transfer their electrons to the anode, as the first step in the microbial fuel cell process.

The Key Players

Mr. Clean
(aka *Shewanella*)

Known for their versatility, *Shewanella* species can be found almost **everywhere** on earth, from mountain soils, to ocean sediments. They have an ability to metabolize a wide variety of elements that are toxic to humans, yet they don't cause disease in humans. They even have the ability to metabolize radioactive **Uranium**, precipitating it out of contaminated waters. These abilities make *Shewanella* an ideal bacterium for **bioremediation** processes.

The Iron-Breather
(aka *Geobacter*)



Known as the **"iron-breather"**, *Geobacter* species have the ability to "inhale" iron compounds and use them in a way similar to the way humans use oxygen. In fact, they prefer to live in environments where there is no oxygen, such as deep underground or within ocean sediments. *Geobacter* species have the ability to consume many environmental pollutants, including **petroleum** and **Uranium**, and have been used in many soil and water **bioremediation** efforts.

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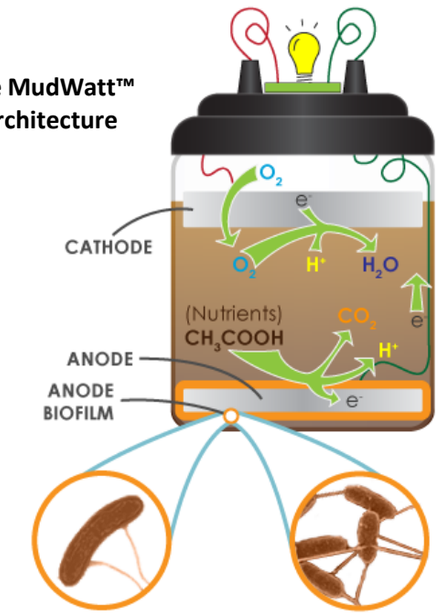

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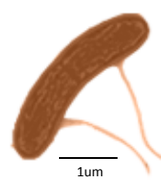

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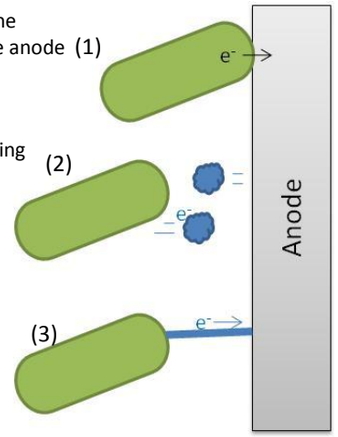
The biomolecules produced by the microbes donate their spare electrons to the anode in one of three ways, as diagramed below:

1) Direct transfer from the microbe's cell wall to the anode surface (1)

2) Meditated transfer using shuttling biomolecules (2)

3) Transferring the electron through conductive appendages, termed "nanowires", grown by the microbe. These nanowires can form vast conductive networks, as shown on the next page (3)



Microbe-Anode Interaction

A microbial community electrically connected by a vast network of nanowires

Once the electron has been transferred to the anode, it then travels to the cathode, where it reacts with an oxygen molecule and a proton, a byproduct of the microbes' metabolism, to form water (as was seen in Figure 1). This process is continued by the billions of microbes on the anode and thus electrical current is generated.

In addition to the microbes on the anode, there are also aerobic (oxygen-breathing) microbes within the soil that consume all the oxygen around the anode. It is this difference in oxygen concentration between the anode and cathode environments that creates the MudWatt's voltage.

With voltage and current, the MudWatt™ generates power (Power = Voltage x Current). We can use this power by placing a small device (such as an LED light) between the two electrodes.

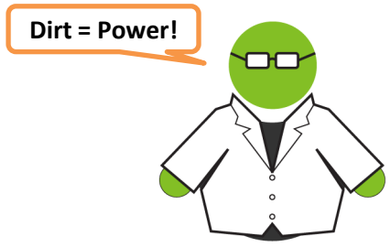
Power generation from an MFC is continuous so long as there are nutrients readily available within the anodic media. Using typical topsoil, the MudWatt™ should last for years.

There is so much more to say about the MudWatt™ and MFCs. For more information, please visit our Community page at www.keegotech.com/community.

***Disclaimer:** The MudWatt™ electrodes are made of graphite fiber, which is a conductive material and will cause shortages when in contact with electronics. Do not to place the electrodes near electronics or power plugs and use care not to disperse fibers into the air. To minimize risk, Keego Technologies encourages customers to use disposable gloves when handling the electrodes.*

MudWatt™ 101

An Intro to Microbial Fuel Cells



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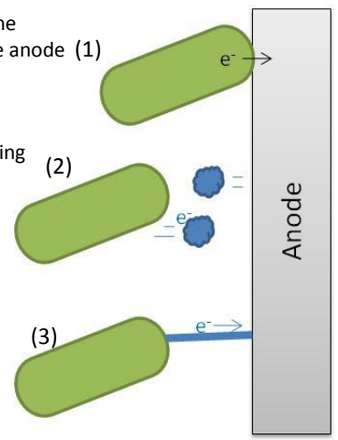

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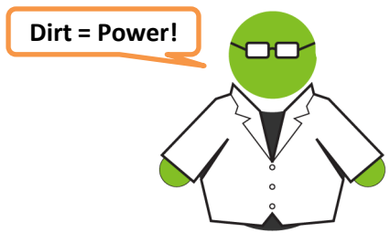

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