

General principles of MFCs

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A microbial fuel cell (MFC) converts chemical energy, available in a bio-convertible substrate, directly into electricity. To achieve this, bacteria are used as a catalyst to convert substrate into electrons.

Bacteria are very small (size appr. 1 μm) organisms which can convert a huge variety of organic compounds into CO_2 , water and energy. The micro-organisms use the produced energy to grow and to maintain their metabolism. However, by using a MFC we can harvest a part of this microbial energy in the form of electricity.

A MFC consists of an anode, a cathode, a proton or cation exchange membrane and an electrical circuit.

A General layout of a MFC in which in the anodic compartment the bacteria can bring about oxidative conversions while in the cathodic compartment chemical and microbial reductive processes can occur. (After Rabaey & Verstraete, 2005)

The bacteria live in the anode and convert a substrate such as glucose, acetate but also waste water into CO_2 , protons and electrons. Under aerobic conditions, bacteria use oxygen or nitrate as a final electron acceptor to produce water. However, in the anode of a MFC, no oxygen is present and bacteria need to switch from their natural electron acceptor to an insoluble acceptor, such as the MFC anode. Due to the ability of bacteria to transfer electrons to an insoluble electron acceptor, we can use a MFC to collect the electrons originating from the microbial metabolism. The electron transfer can occur either

via membrane-associated components, soluble electron shuttles or nano-wires.

The electrons then flow through an electrical circuit with a load or a resistor to the cathode. The potential difference (Volt) between the anode and the cathode, together with the flow of electrons (Ampere) results in the generation of electrical power (Watt).

The protons flow through the proton or cation exchange membrane to the cathode.

At the cathode, an electron acceptor is chemically reduced. Ideally, oxygen is reduced to water. To obtain a sufficient oxygen reduction reaction (ORR) rate a Platina-catalyst has to be used. However, many researchers have tried to use other non-noble metal catalysts.