

Methodology

To conduct this study on whether nitrates will enhance the overall performance of an MFC, first, the cathodes and anodes of the MFCs were built. The endcaps of three ½ inch diameter compression fittings were removed and rubbed against sandpaper to roughen the edges. The opposing sides of six cylindrical plastic containers were roughened up as well in a 1-inch x 1-inch square. The center of the square was marked and drilled by a ¾ inch spade drill bit. Next, the lids of each of the six containers were drilled with a 2-millimeter drill bit, and three of these containers were drilled again for an additional hole using 3/16-inch bit. The flat sides of each of the compression fittings were adhered to the ¾ inch hole on the cylindrical containers using a plastic bonder. This assembly was let to dry for 10 hours, then tested to be watertight by connecting the compression tubes with the endcaps and filling the containers with water. When the water did not leak from the assembly, the tubes were unscrewed and set aside.

The second section of this MFC build was creating the electrodes. A sheet of carbon fiber cloth was cut into six equal 7 x 7 cm squares. Next, six 18-inch pieces of 24-gauge copper wire were insulated completely with the electrical tape except for 6 inches on one end and 2 inches on the other end, as shown in Figure 6. The wires were bent and glued with the conductive wire glue to the carbon fiber cloths, as shown in Figure 7, and let to dry overnight. Following this, the connection between the carbon fiber cloth and bare copper wire was tested with the digital multimeter. When little to no resistance was present, the electrodes were ready.



Figure 6: Copper wire bent for the electrodes. Photos taken by Brindha Srivatsav



Figure 7: Completed electrodes. Photos taken by Brindha Srivatsav

The next step was to make the salt bridges (PEMs). One end of each of the three compression fittings were covered securely with aluminum foil and set aside on a plate, open end up. 300 milliliters of water were measured boiled in a pot. Additionally, 30 grams of agar and 6 grams of salt were measured. The agar was dissolved in the boiling water, and the salt was added after, off the heat. While the solution was still warm, it was poured into the compression fittings and refrigerated overnight. The next morning, the compression fittings were placed into a quart sized Ziploc bag to prevent them from drying out.

The most important part of the experiment, obtaining the benthic mud samples, was done next. The Ken Malloy Regional Park (Lake Machado) was visited to collect sludge sample. Using a shovel, sludge was dug and transferred into a bucket, and covered with plastic wrap.

The final assembly of the MFC was completed next. The six containers built in the first section and the salt bridges made in the third section were retrieved. The salt bridges were screwed into their compression fitting endcaps on the containers. Next, one electrode was placed in each cathode and their bare wires were threaded through the 2 mm hole in the container lid. Distilled water was poured to the top of the 3 cathode chambers and closed with its lid.

Subsequently, the three anode chambers were filled halfway with the sludge samples, then the electrode was placed with its wire threading out of the 2-millimeter hole of the lid. During this step, two MFC anodes were weighed, and in one of them, 5% of coffee grounds were incorporated into the sludge (based on the weight of the anode), and in the other, 10% of coffee grounds were incorporated into the sludge (based on the weight of the anode). The remaining space of the containers were filled with the rest of the sludge sample.

Finally, the MFC testing began. An air pump, which aerates the solution in the cathode chamber, was turned on and tubing was threaded through the 3/16-inch holes of each cathode. Next, each end of a 220-ohm resistor was connected to two pairs of alligator clips, and the external circuit for the electrons to move through was created. As shown in Figures 8-10, one side of the first alligator clip was clipped to the bare copper wire arising from the anode, and the other side was clipped to one end of the resistor. One side of the second alligator clip was clipped to the bare copper wire arising from the cathode, and the other side was clipped to the other end of the resistor. To evaluate the overall performance of all three of the MFCs, the power output and voltage readings were collected. Using the digital multimeter, the MFCs were tested thrice a day during morning, afternoon, and evening, across 21 days. A total of 372 voltage readings were collected (no readings collected during morning of day 1).



Figure 8: Control MFC. Photos taken by Brindha Srivatsav *Figure 9: 5% Coffee Ground Addition MFC. Photos taken by Brindha Srivatsav* *Figure 10: 10% Coffee Ground Addition MFC. Photos taken by Brindha Srivatsav*

***The Ballona Wetlands had to be visited to collect more sludge sample because when the MFCs with the sludge sample from the Ken Malloy Regional Park were tested, no readings were detected. I thought that either the anaerobic bacteria must have died overnight, or that only a very small number of microorganisms were living in the Ken Malloy sludge sample, so not enough ATP was produced to generate readings. Therefore, another site was tried, and the previous MFCs were dismantled and reconstructed with the new sludge sample.**