# Direct Interspecies Electron Transfer Enhancing Methanogenesis in Anaerobic Digestion

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## Introduction


The burning of fossil fuels for energy production is the leading contributor to the world's climate change issue. Biogas produced from anaerobic digestion (AD) is a more sustainable option because it has the potential to make up for 25% of the world's natural gas needs and 6% of the world's primary energy demand (Guo et al., 2015b). These AD systems have already been implemented in wastewater treatment plants (WWTP), to recover a fraction of the embedded energy in domestic wastewater. In the AD process, microorganisms convert organics into methane rich biogas. However, the microbial community itself inhibits the biogas production due to the accumulation of unnecessary intermediates that function as electron shuttles. To reduce the production of intermediates and stimulate methane yield, scientists propose that the addition of an electrically conductive metal will function as the electron shuttle and can replace the functionally redundant intermediates. This phenomenon of transmitting the electrons without intermediates is known as Direct Interspecies Electron Transfer (DIET). To test DIET efficacy, two metals (Magnetite and Graphite) were added to the sludge and were tested against two control conditions (sludge and sludge with food waste (FW)).

## Standard Water Quality Tests

### TS, TSS, and VS Testing

| | Trial (Dish) | Weight of clean dish + cover (g) | Weight of dish + lid + 5 ml sludge (g) | Weight of " " after 105 deg C drying (g) | Weight of " " after 550 deg C furnace (g) | mg Total Solids/L | mg volatile solids/L |
|---|---|---|---|---|---|---|---|
| FW | 1 | 77.6 | 82.5 | 77.9 | 77.6 | 60000 | 60000 |
| FW | 2 | 85.4 | 90.5 | 85.8 | 85.5 | 80000 | 60000 |
| FW | 3 | 84.3 | 89.3 | 84.7 | 84.3 | 80000 | 80000 |
| Sludge | 4 | 88.6 | 93.4 | 88.7 | 88.6 | 20000 | 20000 |
| Sludge | 5 | 83.3 | 88.3 | 83.4 | 83.3 | 20000 | 20000 |
| Sludge | 6 | 79.8 | 85 | 79.9 | 79.8 | 20000 | 20000 |

**Figure 1.** Environmental Engineers utilize Standard Water Quality Tests in order to characterize the sludge and/or food waste that they are using in their research. These tests include Volatile Solids (VS), Total Solids (TS), and Total Suspended Solids (TSS).

## Methods

### Respirometry

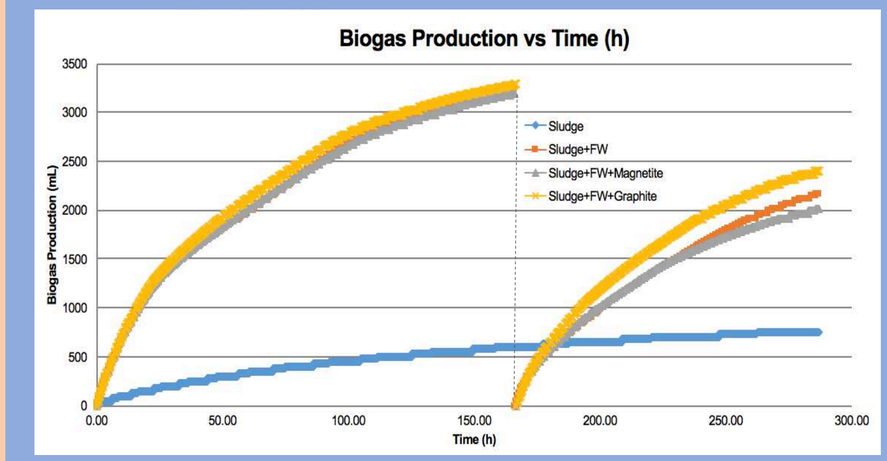



**Figure 2.** Respirometers measured the biogas production in each bottle. Currently, there is not statistical difference; however, this may be due to the microbial community not adapting yet. The dotted line represents when the bottles were opened and 50 mL of solid was wasted. Subsequently, food waste (organics) from Divert Inc. was added to the system and bottles were purged with $N_2$ to restore AD conditions.

### Gas Chromatography (GC)

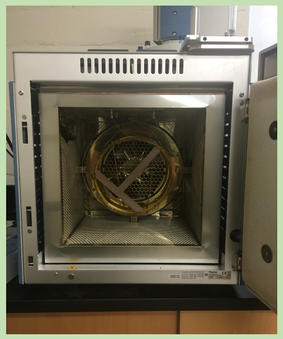


Fig 3.

| Results | | |
|---|---|---|
| Sample | Area | Methane Content (%) |
| 1A | 2065.3089 | 78.32955311 |
| 1B | 1976.895 | 75.22818156 |
| 1C | 1797.2307 | 68.92594009 |
| 2A | 2076.2007 | 78.71161428 |
| 2B | 2059.1675 | 78.11412586 |
| 2C | 2047.8684 | 77.71777747 |
| 3A | 2060.9846 | 78.17786586 |
| 3B | 2046.7699 | 77.67924442 |
| 3C | 2107.9542 | 79.82545952 |
| 4A | 2133.3337 | 80.71571839 |
| 4B | 2025.0309 | 76.91668654 |
| 4C | 1818.6849 | 69.67850779 |

Fig 4.

**Figure 3.** GC is a method scientists use to separate and identify the different types of gas that are present in the volume they are testing. In this experiment, the gas in each bottle was sampled and injected into the GC to detect the methane content.
**Figure 4.** GC results from 7/19/17

## Methods (cont.)

### Ion Chromatography (IC)

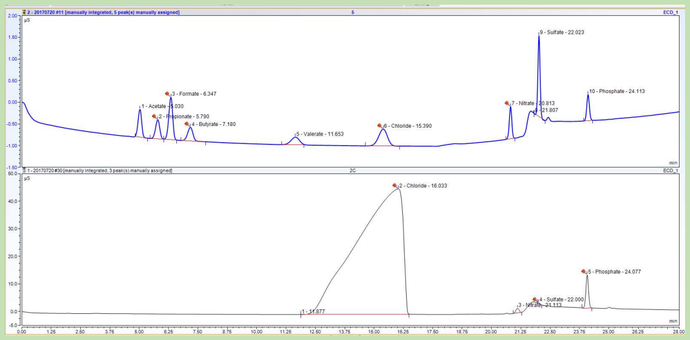
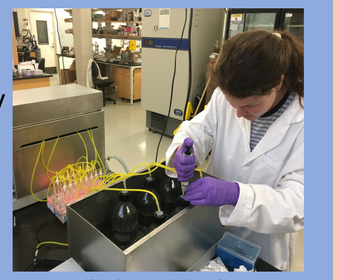



**Figure 5.** IC detects certain compounds in a sample, such as Acetate, Propionate, Formate, Butyrate, Valerate, Chloride, Nitrate, Sulfate, and Phosphate. Solid samples taken from the bottles and inoculum were filtered and tested using IC. The top graph is the calibration curve, with each peak representing a different substance. The graph below depicts the inorganic compounds in sample 2C.

## Skills Learned

- Lab Safety
- How to design an experiment
- Gas & Ion Chromatography
- 3D Design software using AutoCAD
- Operation of respirometer
- How to read and understand Scientific Articles



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