

# Aerobic Food Waste Composting: Measurement of Green House Gases

ISF academy, Hong Kong

## Background

The Independent Schools Foundation Academy is a private independent school in Hong Kong with approximately 1500 students. Each academic year, the school produces 27 metric tonnes of food waste. In November 2013, the school installed an aerobic food waste composting system.

The composting process employs two machines:

- The Dehydra
  - It reduces the mass of the food waste by grinding the food waste into a uniform size and removing excessive water.
- A900 Rocket (See fig. 1)
  - A composter made by Tidy Planet, processes food waste into compost in 14 days. This machine runs in an aerobic process, in which oxygen is required and will emit carbon dioxide



Fig. 1 A picture of the A900 Rocket

Over the past 3 years, various improvements, such as installing a bio-filter to reduce the smell of the compost, have been made to the composting process. Meanwhile the compost is used by the primary students, as part of their experiential learning curriculum and organic farming projects.

As a school, we are committed to reduce the amount of waste we send to the landfill and also reducing our carbon footprint.

## Research Objective

While composting can reduce the amount of waste being sent to the landfills, aerobic composting processes also produce greenhouse gases which in turn contribute to global warming. (EPA)

This research studied different composting systems' GHG emissions for four major GHGs: carbon dioxide, methane, nitrous oxide and ammonia.

## Gas Collection Method

Equipment used (See Fig. 2):

- 1) Siphon pump
- 2) Tedlar bags

Method:

- The suction pipe was inserted 5cm into the compost. Then, the output pipe was connected to the opening valve of the Tedlar bag.
- Around 1000cm<sup>3</sup> of gas was collected at each compost site.



Fig. 2 An picture of the pump and the Tedlar sampling bag

## System Model

In October 2016, ISF Academy acquired a Gasetm DX 4015, a Fourier transform infrared spectroscopy (FTIR) multi gas analyzer. This equipment measures the concentration (ppm) of the GHGs and the data is presented through the Calcmet Analysis software. (See Fig. 3.1 and 3.2)



Fig. 3.1 A setup image of the Gasetm DX 4015

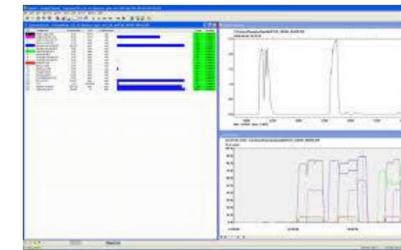
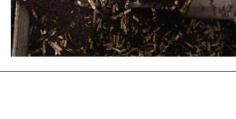


Fig. 3.2 A screenshot of the software

Raw data				
Sample No.	CO <sub>2</sub> (ppm)	CH <sub>4</sub> (ppm)	N <sub>2</sub> O (ppm)	NH <sub>3</sub> (ppm)
1	7377.42	16.20	0.92	0.39
2	1312.17	12.16	0.29	0.55
3	2501.13	36.96	0.61	0.55
4	1398.27	10.37	1.19	40.97
5	1138.00	1.00	0.18	0.70

## Data processing

- 1) 400 ppm, the background CO<sub>2</sub> level on earth, was subtracted from each CO<sub>2</sub> measurements before the ratios were calculated. (EPA)
- 2) Each GHGs data was divided by the corresponding CO<sub>2</sub> reading, which is to find the ratio of CO<sub>2</sub> to the other GHGs. The ratios are shown below in scientific notation. This ratio normalized the data because the sample of gas collected in the Tedlar sampling bag was not exactly the same for each sample.

Ratio of Greenhouse Gases vs. CO <sub>2</sub>					
Sample No.	Description and type of composting	Picture of the compost	[CH <sub>4</sub> ]/[CO <sub>2</sub> ]	[N <sub>2</sub> O]/[CO <sub>2</sub> ]	[NH <sub>3</sub> ]/[CO <sub>2</sub> ]
1	A 4 month compost pile, which is regularly turned and aerated.		$2.3 \times 10^{-3}$	$1.3 \times 10^{-4}$	$5.6 \times 10^{-5}$
2	Same as above, but it is a 2 month pile.		$1.3 \times 10^{-2}$	$3.2 \times 10^{-4}$	$6.0 \times 10^{-4}$
3	Vermicomposting, using earthworms to decompose food waste and generate humus in 2 months time		$1.8 \times 10^{-2}$	$2.9 \times 10^{-4}$	$2.6 \times 10^{-4}$
4	Compost generated by a machine called AEL Food Waste Composter.		$1.0 \times 10^{-2}$	$1.2 \times 10^{-3}$	$4.1 \times 10^{-2}$
5	Compost produced by the A900 Rocket at ISF Academy		$1.4 \times 10^{-3}$	$2.4 \times 10^{-4}$	$1.0 \times 10^{-3}$

## Discussion

- Sample No.1 is a 4-month-old compost pile. While it has the lowest CH<sub>4</sub> to CO<sub>2</sub> ratio, its CO<sub>2</sub> concentration is the highest among the 5 samples and more than 6 times of the lowest one.
- Sample No. 2 had the same process as No. 1, but with only two months piling. As a result, both the CH<sub>4</sub> to CO<sub>2</sub> ratio and NH<sub>3</sub> to CO<sub>2</sub> ratios of No. 2 are 10 times higher than No. 1.
- Sample No. 3 is a product of vermicomposting, leading to 37 ppm of CH<sub>4</sub> which is the highest reading and double the second highest sample generated by an aerobic composting system.
- The NH<sub>3</sub> to CO<sub>2</sub> ratio of Sample No. 4 is 40 times more than the second highest reading. Through smell test, its strong odor was evident that the ammonia was significantly higher, which might be caused by an imbalance of the composting formula.
- Lastly, gas sample No. 5 collected from the A900 Rocket at ISF with enriched nitrogen from coffee grounds has the lowest concentration of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O as measured by ppm.

## Conclusion

The gas sample collected from the ISF compost machine has the lowest emission of GHGs among all 5 samples. According to the Gasetm readings, the low concentration of methane (1 ppm) suggests that the food waste composting process in ISF is mostly aerobic, however when compared by evaluating the GHG ratios, it is apparent that nitrogen levels are higher than the other types of composting.

## Next Steps in Research

- Since there was only one gas sample collected at each composting site, further research will include more trials to show the reliability and statistical validity of the results.
- The ammonia and nitrous oxide gases could be reduced by "fine tuning" the amount of nitrogen added to the compost mix.
- More accurate calculation of the background CO<sub>2</sub> concentrations at the time and location of the sampling.

## Acknowledgements

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