Food to Fuel: Anaerobic Composting at Rutgers New Brunswick, NJ.

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Abstract

Disposal of food at Rutgers is handled in a questionable manner and could be more efficient. Rutgers currently spends close to $100,000 to get rid of leftover food at the dining halls. The food is taken by a pig farmer to feed his pigs; this does nothing to benefit the Rutgers community. By implementing an anaerobic digestion chamber on campus this food disposal fee will no longer be required. The philosophy behind the anaerobic digester is that the leftover will be converted to natural gas that can be utilized by Rutgers. This is achieved by specifying conditions within the chamber that are optimal for specific microorganisms that breakdown the leftover foods and convert them to gas. The process is akin to composting. The starting cost to implement the chamber will be outweighed over the span of a few years by the amount the University saves by not paying the pig farmer. This does not include the savings from the utilization of the fuels generated by this process or the environmental benefit of the chamber.

Introduction

Organic food wastes have potential to be converted into fuel and other products in a number of ways through recent technological innovations. There is always a steady supply of food waste that goes by the wayside in landfills and generates gases that are harmful to the atmosphere. In fact in 2000 each New Jersey Resident generated about 310 pounds of food waste a year (Hayes and Adelaja 2004). The current population of New Jersey is 8,682,661 (US Census 2010) and with some simple multiplication it is easy to see that over a million tons of food waste is generated annually across the state. The food waste that is generated by the Rutgers New Brunswick dining facility and catering services can be recycled along with other organic wastes generated by the University to create new energy. In other words the biomass produced by the University can be converted to bioenergy through the means of anaerobic digestion.

Anaerobic digestion (AD) reduces food waste and landfill size while providing natural gas that can be used as an energy source. (Doelle, 2001; EPA, 2008; Friends of the Earth, 2004). The AD processes involves an airtight vat that contains the biodegradable composting material, and over a few days anaerobic microorganisms, organisms that survive in low or oxygen depleted environments, digest the material and produce natural gasses. (Doelle, 2001; EPA, 2008; Friends of the Earth, 2004). An AD reduces the size of landfills, methane emission from the landfills and vehicle emissions by eliminating the food waste that go into landfills, trapping the gas that is naturally put off, and using the gas in an efficient way. The AD will also eliminate leaf removal problems by incorporating the foliage into the digestion process. In the US the AD are used on manure and municipal solid waste and by digesting this alone would benefit the environment, but a food waste disposal system could decrease landfill size and green house gas emissions drastically.

Methods of AD

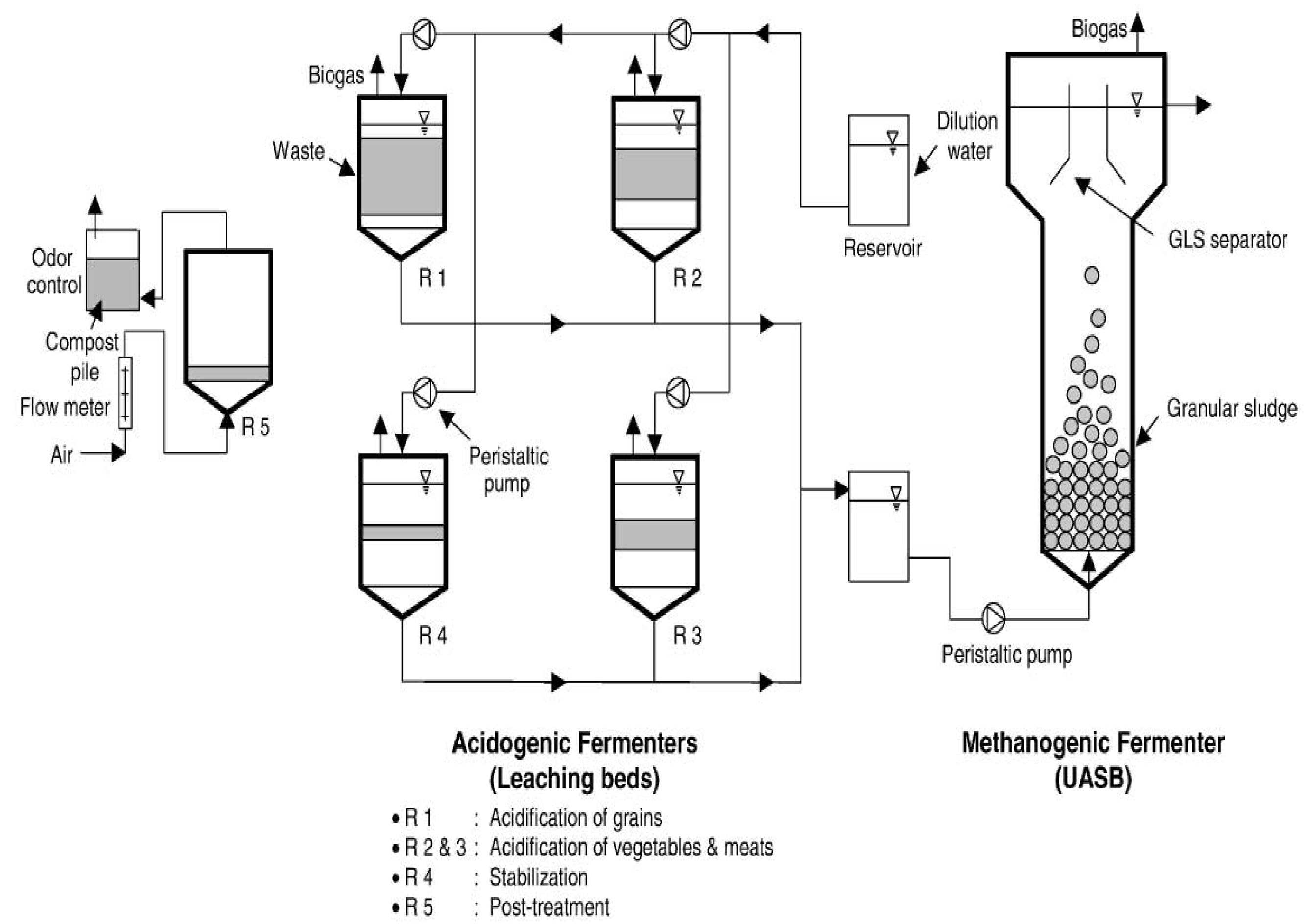

Image 1: The image below shows a schematic of a multi-step sequential two-phase anaerobic composter that is similar to the BTA-Plant sold by CCI (Shin *et. al.,* 2001).

The companies that are most involved in the Northern American market for AD plants include Dranco, Valorga, Arrowbi, BTA, and Kompogas (Kelleher, 2007). There are many types of food waste AD including a wet single and multi-step process, a dry continuous, sequencing, and multi step process (AD Feasibility Study, 2004). Out of all of the different types of anaerobic digesters the one most suitable for Rutgers New Brunswick campus is the multi-step continuous wet process with percolation; more specifically the mobile-pilot BTA-Plant sold by Canada Composting Inc (CCI). The BTA-Plant is a 10 ton anaerobic digester that includes eight different units including a pulper, a GRS/gas compressor container, the digester, a dewatering container, a process water tank container frame, a gas holder tank, a combined Heat and Power (CHP) container, and a control system.

Finances

The initial cost of the described model plant would have an upfront cost of around $2 million (Canada Composting Inc). There would be maintenance, employee, hauling and general costs to the start up of the plant that would require a significant investment. The would save the University around $142,354.40 per year (Recycling Data, 2008) in avoided haul away costs of food waste, tree/grass waste and paper product recycling. The plant would also generate natural gas which can be used as fuel or electricity. One ton of food waste that is anaerobically digested under the condition of the BTA model can generate 100 to 200 m^3 of biogas (Clarks, 2009). The amount of biogas/natural gas equivalent to one gallon of gasoline is 3.587 m^3 (Gable S. and Gable C. 2010) and if the digester produces a conservative 100 m^3 per ton of food while processing around 10 tons per day that means daily the plant would produce the equivalent of 279 gallons of gasoline a day. The average cost of CNG per gallon equivalent ranges from $1.50 to $2.50 (US Department of Energy 2009). If all the surplus fuel generated was to be sold at a conservative price $2.00 per gallon gasoline equivalent it would generate $132600.00 per year. This revenue in combination with the savings from the avoided haul away costs would mean that the payback time for the small AD plant would be about 4 years.

Image 2: The area on Livingston campus that would be ideal is highlighted in the picture below

Logistics

There are many considerations that must be taken in the application of this type of anaerobic digester on the Rutgers New Brunswick campus. The main developmental challenge is finding an appropriate space on campus for the AD plant. The Livingston campus of Rutgers New Brunswick has a lot of open space and already has a compressed natural gas filling station for the cars that use this fuel. Thus it would be ideal for the plant to be built in this location due to its seclusion from residents and proximity to the compressed natural gas filling station. In addition to being remote, the plant is still accessible by trucks that could haul the food waste to the plant. The implementation of an AD plant would require that Rutgers University have trucks haul food waste from its dining and catering facilities to the plant. This process is feasible because Rutgers already has a fleet of vehicles capable of moving the waste within the various campuses. The current system in place for the pick of waste by the pig farmer could be maintained only Rutgers University would move the waste instead.

Conclusion

Anaerobic digestion is environmentally healthy and a practical solution to the rising problem of global warming and landfill dumping. Using an AD for food waste instead of selling the food to a pig farmer would:

-Reduce Rutgers' carbon foot print by incorporating more CNG vehicles
-Save the money that would have been given the pig farmer (over $120,000/yr)
-Eliminate leaf removal costs (about $500/year)
-The initial investment would be paid back within 4 years of the start of the project
-After 4 years the plant would generate a combined profit and savings that would amount to about $200,000 per year
-Rutgers would become a stepping stone for the rest of NJ to follow