Anaerobic Digestion of Municipal Solid Waste, An Opportunity for Energy Recovery and Landfill Management

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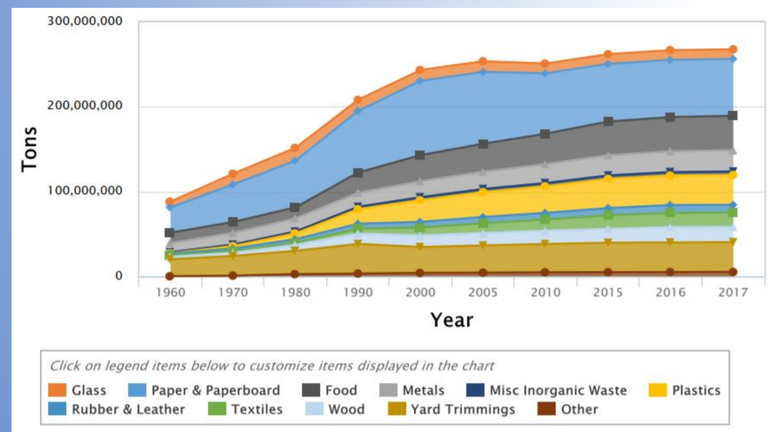
Engineering Technology

Introduction

According to the US Environmental Protection Agency (EPA), a total of 267.8 million tons of municipal solid waste (MSW) was produced in the U.S. in 2017. Fox 17 News reported that Middle Point Landfill in Rutherford County is "running out of room," Nashville residents increased more than 100 thousand tons of MSW from 2017 to 2018. Management of MSW becomes more difficult every year. The current treatment techniques in landfills are not efficient enough considering the huge volume of solid waste and space limitations. Therefore, more sustainable strategies capable of handling these enormous amounts of MSW are necessary to be developed.



Municipal Solid Waste Generated in the U.S. from 1960 to 2017.
EPA National Overview: Facts and Figures on Materials, Wastes and Recycling
https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

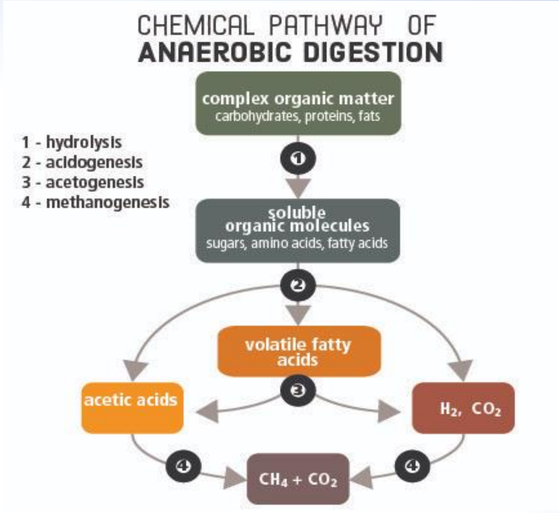
Anaerobic Digestion Process

Anaerobic digestion (AD) is a relatively new technology that can transform waste into useful type of energy, i.e., biogas.

This research presents the development of an AD system capable to generate energy in the form of methane gas using solid waste, resulting in waste volume reduction in the landfills.

AD includes a series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen The AD process is divided in four major steps:

1. **Bacterial hydrolysis,**
2. **Fermentation**
3. **Acetogenesis**
4. **Methanogenesis**

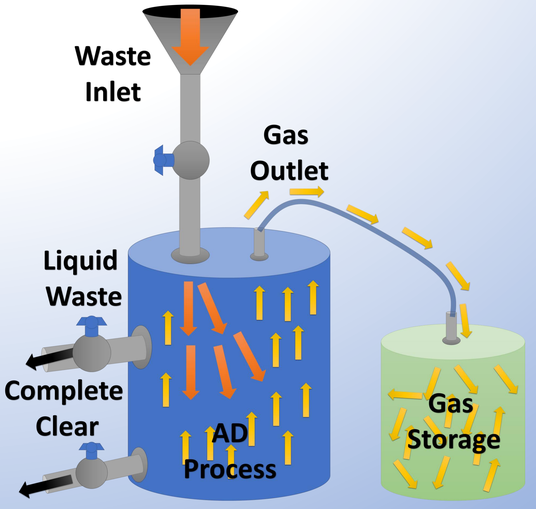


System Design

The initial system is conformed by a 55-gallon tank, with four circular wholes used to feed waste and collect gas from the system. There is one inlet and three outlets, the inlet is located at the top of the tank (waste feed), one outlet at the top of the tank (gas collection), one outlet at ¾ of the tank (liquid waste), and the last outlet near the bottom of the tank (complete clear). The liquid waste and complete clear outlet are connected to a pipe system directed to collection storages; the feed inlet has funnel and faucet connections; Finally, the gas collection outlet is directed to another tank where the methane gas is stored.

Procedure: The waste is deposited inside a digester tank, where the AD processes happen.it is transformed into two main parts, methane gas and residues. The biogas is collected and stored using a small pipe system that allows to keep an anaerobic environment, and the residues are ejected out of the tank using the faucets on the outlet pipes.

The volume reduction could be monitored inside the digester tank.



Experiment Design & Expected Results

- The experiment is designed to find the optimum conditions where the highest volume of organic solid waste is reduced and generate methane gas.
- The experimental variables are temperature, pH, pressure, and feedstock composition.
- The system has periodic restock of waste depending on the amount processed. The experimentation process is continuously operating for a period of two months before optimizing changes are made.
- Other expected results include the average rate of waste reduction, and average rate of gas production per volume of waste in optimum environment.

References

- Li, Y., Chen, Y., & Wu, J. (2019). Enhancement of methane production in anaerobic digestion process: A review. *Enhancement of Methane Production in Anaerobic Digestion Process: A Review*, 120–137. doi: 10.1016/j.apenergy.2019.01.243
- National Overview: Facts and Figures on Materials, Wastes and Recycling. (2019, December 3). Retrieved from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials
- Dombrowski, B. (2018, December 4). What is Anaerobic Digestion? Retrieved from https://americanbiogascouncil.org/resources/what-is-anaerobic-digestion/
- Vasco-Correa, J. (2018, June 15). Economic Implications of Anaerobic Digestion for Bioenergy Production and Waste Management. Retrieved from https://ohioline.osu.edu/factsheet/fabe-6611
- Jyothilakshmi, R., & Prakash, S. (2016). Design, Fabrication and Experimentation of a Small Scale Anaerobic Biodigester for Domestic Biodegradable Solid Waste with Energy Recovery and Sizing Calculations. *Procedia Environmental Sciences*, *35*, 749–755
- Mao, C., Feng, Y., Wang, X., & Ren, G. (2016). ChemInform Abstract: Review on Research Achievements of Biogas from Anaerobic Digestion. *ChemInform*, *47*(28).
- Case, S. (2019, August 23). Project Nashville: Landfill filling up, quickly running out of room. Retrieved from https://fox17.com/news/project-nashville/project-nashville-landfull-filling-up-quickly-running-out-of-room

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