Anaerobic Digestion- Introduction to pH Effects, part 1

INTRODUCTION

Anaerobic digestion is a biological process that produces a gas principally composed of methane (CH_4) and carbon dioxide (CO_2) otherwise known as biogas. These gases are produced from organic wastes such as livestock manure, food processing waste, etc.

Anaerobic processes could either occur naturally or in a controlled environment such as a biogas plant. Organic waste such as livestock manure and various types of bacteria are put in an airtight container called digester so the process could occur. Depending on the waste feedstock and the system design, biogas is typically 55 to 75 percent pure methane. State-of-the-art systems report producing biogas that is more than 95 percent pure methane.

Microbes responsible for anaerobic digestion rely on steady pH levels ranging from 6.8-7.2. Buffer systems can be set in place in order to ensure this stability. Two such buffers are sodium bicarbonate and calcium carbonate, which can be added to batch digestors at start of digestion.

TASK(S)

Activity 1 (30 minutes)
Digestion prep and set up
Activity 2 (50 minutes- 7 to 10 days following Activity 1)
Digestion analysis

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ACTIVITY/PROCESS

Digestion Prep and Set Up

- Separate into groups of 2-3 students
- Set water baths to 55 centigrade
- Obtain 3 plastic bottles for digestion vessels per group. Label as the following treatments: untreated, sodium bicarbonate, and calcium carbonate
- Record weight of all empty vials. Add approximately 100mL sludge from onsite digester, cap and record weight.
- Add approximately 50g of homogenous waste substrate (collected from home, lunch, coffee grounds, etc). Cap and record total weight
- To the vessel label sodium bicarbonate, add approximately 20g of sodium bicarbonate, cap and record weight
- To the vessel label calcium carbonate, add approximately 20g of calcium carbonate, cap and record weight
- Place digesters in water baths for 7-10 days.

Digestion Analysis

- Weigh each vessel
- Degas (unscrew cap, but do not remove)
- Weigh each degassed vessel
- Measure methane using gas sniffer (E Instruments) and carbon dioxide content using LabQuest (Vernier)
- Measure pH, temperature of digestate, using LabQuest (Vernier)
- Create data table, bar chart, and perform class-wide ANOVA analysis using Microsoft Excel

RESOURCES

Excerpt from The Microbiology of Anaerobic Digesters. Gerardi, M. John Wiley & Sons, Inc. Canada (2003). Chapter 16: Alkalinity and pH. pp99-104.

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ASSESSMENT

- Identify strengths and weaknesses in data collection, graphing, and statistical analyses
- Discuss relationship among the anaerobic processes, and how that can be connected to conservation of mass
- Using data collected, write brief summary of the relationship among pH and biogas production
- Relate the effect that pH changes may have on viability of digestion and the processes that may contribute to those changes.