Anaerobic Digestion- Introduction to Temperature Effect

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.

The microbes responsible for anaerobic digestion are active at two temperature stages. The first is 30 to 35 Centigrade, called the mesophilic range. The second is the thermophilic range which is between 50 and 60 Centigrade. Temperatures falling out of these two ranges are not conducive for methane production.

Note: This lesson plan is similar to that of Anaerobic Digestion-Introduction to pH Effects-part 1 and can be done simultaneously if supplies are available.

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 35 and 55 centigrade
- Obtain 3 plastic bottles for digestion vessels per group. Label as the following treatments: untreated, 35 centigrade, and 55 centigrade
- 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
- Construct and record hypothesis as to which treatment will produce more biogas, and another as to which will produce a higher percentage of methane within the biogas
- Place digesters in water baths for 7-10 days, recoding water bath temperature daily

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
- Discuss conclusions in terms of recorded hypotheses

RESOURCES

Excerpt from The Microbiology of Anaerobic Digesters. Gerardi, M. John Wiley & Sons, Inc. Canada (2003). Chapter 14: Temperature. Pp89-92.

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ASSESSMENT

- Identify strengths and weaknesses in data collection, graphing, and statistical analyses
- Discuss relationship among the anaerobic processes, and how they are related to temperature
- Using data collect, write brief review contrasting mesophilic and thermophilic in terms of biogas and methane production. Reviews should incorporate data charts.
- Relate the effect that temperature changes may have on viability of digestion and the processes that may contribute to those changes.
- Create flow chart of the scientific method using this experiment as example.