Improving Cold Region Biogas Digester Efficiency

Cordova Electric Cooperative

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Project Summary

- **Cordova Electric Cooperative**
  - Cordova High School
  - University of Alaska, Fairbanks

- **Location:** Cordova High School- Cordova, AK

- **Technology:** Cold-weather Anaerobic Digestion for Methane Production

- **Project Goal:**
  
  “Improve conventional anaerobic digester efficiency through use of *psychrophilic* (cold adapted) bacteria cultivated from arctic lake sediments found in Alaska in order to provide cooking and heating fuel for Alaskan households.”
Technology Overview

Anaerobic Digestion

- Bacteria obtain energy by consuming organic material in an anaerobic environment.
- Results in the formation of carbon dioxide and methane (CH$_4$)
- Methanogens- bacteria which produce methane as a waste product.

Metabolic pathway for biogas production
**Methanogens**

**Mesophilic** - Moderate temperatures, typically between 25 and 40 °C (77 and 104 °F).

**Psychrophilic** - Cold temperatures, ranging from −15 °C to +15 °C.
Current Application - Small-Scale
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India: 8 Million Biogas Digesters

China: 20 Million Biogas Digesters
Current Application - Industry

- **Biogas Kristianstad**, Kristianstad, SE
  - Capacity: 3000 MWh

- **Vanderhak Dairy**, Lyden, WA
  - Capacity: 500kWh

- **Bio-Teere Systems, Inc.**, Eugene, OR
  - Capacity: 150kWh

- ** imaginations at work**

- **SIEMENS**

- **WASTE MANAGEMENT**

- **CATERPILLAR**
Temperature Limitation

[Map showing temperature limitations with lines indicating January and July temperatures of 15°C and the Tropic of Cancer and Capricorn.]
Psychrophiles

Where do we find cold-loving methanogens?

**Alaskan thermokarst-lake sediments**

- Methane production at 0-1°C to 21°C
- 4x more efficient than European psychrophiles that live at 5°C
Opportunities for Alaskan use

- **Small-scale**
  - Individual homes/rural communities
  - Offset high diesel fuel cost
  - Feasible? - Goal of this study

- **Large-scale**
  - Fisheries wastes: Coastal Southeast/Southcentral
  - Municipal wastes: ubiquitous throughout AK
  - Agri-business: Anchorage, Palmer
Alaska Application

Benefits

- Produces a renewable fuel from locally available resources.
- Mitigates health and environmental safety problems associated with waste disposal.
- Reduces fossil fuel demands.
- Produces fertilizer for agricultural efforts.
- Reduces greenhouse gasses released into the atmosphere.
- Puts Alaska at the head of cold-adapted digestors globally and makes Alaska one of the initiating areas to use digestors in the USA.

Photo Credit: Laurel McFadden
Phase 1 - Experiment with different types of methanogens in two controlled environments.
### Biogas Flame Test

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<tr>
<th>Digestor</th>
<th>First Biogas Produced</th>
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<tr>
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</tbody>
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Tasks & Timeline - Phase 1

Food Processing

- Collect school lunch scraps
- Blend into “slurry”
- Feed digester
Engineering in Action

Student-driven engineering of food processing and feeding.
Phase 1 - Challenges

- **Temperature Control**
  - Greatest influence on metabolic rate

- **System Design**
  - Reactor and gas-storage containers must be robust
  - Water gas-collection systems freeze in Alaskan climate

- **pH Concerns**
  - At low temperatures, the anaerobic digestion process can become imbalanced.
    - Acedogen production outpaces methanogen production.
  - Favorable pH for methanogenesis is 6.5-7.5

Gerardi, M. 2003 *The Microbiology of Anaerobic Digesters.* 23-45
Tasks & Timeline: Phase 2

Phase 2
March 1st - August 30th

UAF
Handbook for Alaskans
Gas Storage

Cordova High School
Ongoing Chemical Analysis
CHS Science Club
Effluent as Liquid Fertilizer Study
Biogas Applications

Economic Feasibility Study performed by ACEP
Adam Low
Curriculum Development
Project Status

Collection
Project Status

Greenhouse
Project Status

Application
Project Status

Application
Questions?

www.cordovaenergycenter.org
In the Press


http://www.kristianstad.se/upload/Sprak/dokument/2%20Biogas%20Kristianstad%20brochure%202009.pdf