Potentials and challenges of biogas from fish industry waste in the Arctic

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Content

• Introduction
• Why make biogas in the Arctic?
• Why is it not done already?
• Biogas potential of fish residues and organic waste
• Perspective
Present challenges

Fish industry residuals
- Major part disposed off at sea
- Oxygen depletion at seafloor
- Methane emission

General waste
- Organic household waste
- Sludge from wastewater treatment
- Bag toilet and septic tank content

Can we make the anaerobic digestion happen under controlled conditions, collect biogas and utilize the energy?
Envisioned challenges

Simplified overview of anaerobic digestion process

- Shrimp, crab: Protein → Ammonia → Inhibition
- Halibut: Lipids → Inhibition of methane
- Cold, changing climate
- Lack of local specialists
- Seasonal shift in loading material and rate

**Complex polymers**
Proteins, Polysaccharides etc.

**Fermentative bacteria**

**Proteins**

**Long chain fatty acids**

**Fermentative bacteria**

**H₂ + CO₂**

**Acetogenesis**

**Acetate**

**CO₂ reducing methanogens**

**CH₄ + CO₂**

**Acetotrophic methanogens**

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Biogas plants

Can be very simple installation or highly industrialized optimized plant.
Biogas use

- Electricity – requires large scale plant + energy conversion
- Vehicles – biogas from vegetable products, requires upgrading of gas
- Heat or cooking – can be used directly
  - Simple technology for use of gas to e.g. heat water for boiling of shrimps or heating of buildings
Low temperatures
Slower – higher retention time – larger tank

Lower risk of inhibition and instability at mesophilic conditions

<table>
<thead>
<tr>
<th>Thermal stage</th>
<th>Process temperatures</th>
<th>Retention time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychrophilic</td>
<td>&lt; 20ºC</td>
<td>70 – 80 days</td>
</tr>
<tr>
<td>Mesophilic</td>
<td>30 – 42 ºC</td>
<td>30 – 40 days</td>
</tr>
<tr>
<td>Thermophilic</td>
<td>43 – 55 ºC</td>
<td>15 – 20 days</td>
</tr>
</tbody>
</table>
Methane potential

Literature values, thermophilic

Our measurements, mesophilic

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Methane potential

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In Sisimiut

> 80% of energy used for heating at shrimp processing plant
Hygienization of blackwater

Anaerobic  Mesophilic incubation  Aerobic


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Other options

• Shrimp flour
  – Local experience
  – Low price
  – Only shrimp residuals
• Bio oil
  – Only halibut
• Chitin
  – Advanced processing
• Food for fish farming?
• Food for dogs?
Conclusions and outlook

- Fish and seafood by-product do have significant biogas potential.
- Risk of instability of process due to high lipid and protein content, change in temperature, seasonal variations in loading, lacking of local experts.
- Mesophilic conditions may help stabilize process + reduce need of heating/insulation.
- Mixing with organic food waste, sludge and/or algae may help stabilize process + solve mutual waste challenges – needs to be investigated.
- Knowledge exists for operation, but innovation is needed prior to successful implementation.
Questions