Biogas Upgrading

Alexander Ryhl, Sales Coordinator, Engineer
About AMMONGAS

• Engineering company specialized in air and gas purification systems.
• Located in Copenhagen, Denmark.
• Experience in Norway, Finland and Denmark.

• Alexander Ryhl
  • Sales Coordinator, Engineer.
  • Global Business Engineer, DTU
  • Ammongas since 2016.
Biogas upgrading

- Presurless system
- Low power consumption
- High CO$_2$ separation efficiency – Meaning high CH$_4$ purity
- Methane slip below 0.1 %
- No pre-treatment of raw biogas (H$_2$S, VOC etc.)
- Separates 99% of H$_2$S along with the CO$_2$
- CO$_2$ can be used for other applications
Biogas upgrading

- Absorption/desorption of CO\(_2\) using amines

- CO\(_2\) reaction with water \(\rightarrow\) carbonic acid.
  
  \[
  CO_2 + H_2O \Leftrightarrow H_2CO_3
  \]

- Carbonic acid reacts with amine.
  
  \[
  RNH_2 + H_2CO_3 \Leftrightarrow RNH_3^+ + HCO_3^-
  \]
Bio-methane purity

<table>
<thead>
<tr>
<th>Component</th>
<th>Mol %</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{CH}_4$</td>
<td>99.56</td>
</tr>
<tr>
<td>$\text{CO}_2$</td>
<td>0.0014</td>
</tr>
<tr>
<td>$\text{H}_2\text{S}$</td>
<td>0.000</td>
</tr>
</tbody>
</table>

- $\text{CH}_4$: 99.56 mol %
- $\text{CO}_2$: 0.0014 mol %
- $\text{H}_2\text{S}$: 0.000 mol %
Biogas upgrading

Power consumption [kWh/Nm³]

Methane slip %

SGC Rapport 2013:270

2018.08.14 / AR
• Consumed heat in desorption can be re-used in the biogas plant
Heat recovery

+ 90% of heat re-used!
Heat recovery
Biomass heat exchanger
Modular design
Bio-methane uses

Transport

Injection to natural gas grid
Hashøj Dk 250 m³/h

- Pilot plant.
- Commissioned in 2011.
- Currently used to test new solvents and working conditions.
- We have a close cooperation with customers and suppliers to continuously improve our systems.
Gas for Transportation

Hamar, Norway

- Treats 300 m$^3$/h biogas

Stormossen, Finland

- Biogas from waste handling and WWTP
- The Bio-Methane is used for municipality busses and garbage lorries
- Closed loop
Gas for Transportation

Frevar, Norway

- Treats 600 m³/h of biogas
- Biogas from WWT and bio-waste
- Bio-methane is bottled and used for municipality busses
Gas for Grid Injection

Skive, Denmark

- Small small sized grid injection plants
- Treats 1200 m³/h and 500 m³/h of biogas

Avedøre, Denmark

- Biogas from anaerobic digestion of agricultural waste and energy crops, and WWTP
- Bio-methane injected into the national gas grid for Natural Gas replacement
Gas for Grid Injection

IVAR, Norway

- Medium sized grid injection plants
- Treats 1500 m$^3$/h of biogas
- Biogas from anaerobic digestion of waste water and bio-waste, and agricultural waste
- Bio-methane injected into the local and national gas grid for Natural Gas replacement

Iglsø, Denmark
Gas for Grid Injection

- Medium sized grid injection plants
- Treats 1800 m³/h of biogas
- Biogas from anaerobic digestion
- Bio-methane injected into the national gas grid for Natural Gas replacement
Gas for Grid Injection

Horsens, Denmark

- Large sized grid injection plants
- Treats 3000 m³/h of biogas
- Biogas from anaerobic digestion
- Bio-methane injected into the national gas grid for Natural Gas replacement

Vrå, Denmark
Hashøj, Denmark, 2011: 250 Nm\(^3\)/h: Biogas plant: Pilot plant.
Fredrikstad, Norway, 2013: 600 Nm\(^3\)/h: Waste water and biogas plant: Local transportation use.
Skive, Denmark, 2014: 1,200 Nm\(^3\)/h: Biogas plant: Injection to natural gas grid.
Hamar, Norway, 2015: 300 Nm\(^3\)/h: Waste water plant
Horsens, Denmark, 2015: 3,000 Nm\(^3\)/h: Biogas plant: Injection to natural gas grid.
Stavanger, Norway, 2016: 1,500 Nm\(^3\)/h: Waste water plant Injection to local gas grid.
Stormassen, Finland, 2017: 300 Nm\(^3\)/h: Biogas plant: Local transportation use.
Avedøre, Denmark, 2017: 500 Nm\(^3\)/h: Waste water plant: Injection to natural gas grid.
Vrå, Denmark, 2017: 3,000 Nm\(^3\)/h: Biogas plant: Injection to natural gas grid.
Månsson, Denmark, 2018: 1,500 Nm\(^3\)/h: Biogas plant: Injection to natural gas grid.
Grønhøj, Denmark, 2018: 1,500 Nm\(^3\)/h: Biogas plant: Injection to natural gas grid.
Iglsø, Denmark, 2018: 1,500 Nm\(^3\)/h: Biogas plant: Injection to natural gas grid.

In process:
Ribe, Denmark, (2018): 2,250 Nm\(^3\)/h: Biogas plant: Injection to natural gas grid.
Storde, Denmark, (2018): 1,500 Nm\(^3\)/h: Biogas plant: Injection to natural gas grid.
Thank you for your time