Biogasclean is a **world leader in biological desulfurization** of biogas

**CASA/CWEA Innovative Technology Seminars**

**October 2021**
2 Locations
Headquarter and management in Denmark; engineering and production in Thailand

+30 employees
Employees in Denmark, Thailand, USA, Malaysia and Brazil

+300 References
In 40 different countries

+650 MW
Biogasclean supplies clean gas to more than 650 MW gas engines and boilers and removes sulfur from +20 upgrading plants
Biogasclean has developed two technologies for biological desulfurization of biogas and developed a technology for biological methanation of carbon dioxide (CO₂) and hydrogen (H₂) to electro-methane (e-CH₄) or E-Fuel.

**Biological desulfurization**

- Biogasclean has developed two different technologies – **BTF** (Bio Trickling Filter) and **MBR** (Moving Bed Reactor) and offer five different types of gas cleaners. The gas cleaners can be designed to handle any flow and H₂S content in the raw biogas or tail gas (CO₂ stream) from biogas upgrading and can be installed at greenfield projects or refurbishment of existing plants.

**Biological methanation**

- Biogasclean has together with Nature Energy and two Danish universities developed a **Power-To-X project called E-Fuel**. E-Fuel will enable biogas plants - from the same amount of organic input - to increase their production of green gas by more than 60%!
Our core competences

1. Biological desulfurization of Biogas on **CHP-projects**

2. Biological desulfurization of CO2 on **RNG-projects**

3. Biological methanation of CO2 and H2 in the **Power-2-X sector**
Wastewater streams contain different amounts of sulfur compounds. Under atmospheric conditions – in the presence of oxygen - the sulfur is mainly bound as sulfate (SO\textsubscript{4}) and dissolved in the wastewater.

In the anaerobic digesters the organic matters are degraded by anaerobic bacteria. In the absence of oxygen the sulfate is converted to hydrogen sulfide (H\textsubscript{2}S) which is a gas.

Thus, after the anaerobic digestion process, the sulfur compounds present in the inlet stream leave the reactor through the biogas as H\textsubscript{2}S.

Typically, the H\textsubscript{2}S in the biogas will be in the range from 0.1% to 3.0% (1,000-30,000 ppm).
Why it is mandatory to remove H₂S from biogas

H₂S will form sulfur dioxide (SO₂) and sulfuric acid (H₂SO₄) during combustion which results in a very aggressive corrosion. The corrosion will literally reduce the lifetime of the downstream equipment by years! This is why gas engine manufacturers require that H₂S in the clean gas must not exceed 100-250 ppm. Otherwise, operating costs for change of engine oil, sparkplugs and other maintenance will increase significantly.
Removal of H₂S from Biogas Example

Client: IPG
Enduser: Western Superior Sanitary District, Sector: WWTP
Location: Duluth, Minnesota
Year: 2016

Biogas flow: 695 scfm
H₂S inlet: 3,500ppm
H₂S outlet: 100 ppm
Removal of H₂S from CO₂

Why it is mandatory to remove H₂S from CO₂

Air quality standards are another driver for H₂S removal. Combustion of un-cleaned biogas will result in sulfur dioxide (SO₂) emissions which causes serious odor problems as well as acid rain. Also health and safety standards require H₂S removal as H₂S is toxic even in small concentrations.

In upgrading projects the biogas is converted to bio-methane or Renewable Natural Gas (RNG) by separating the CO₂ from CH₄. The H₂S will follow the CO₂ stream. Before releasing the CO₂ into the atmosphere the H₂S has to be removed.
Removal of H$_2$S from CO$_2$

Example

Client: Lundsby Biogas
Enduser: Vinkel Bioenergy
Application: RNG - Grid injection
Location: Skive, Denmark
Year: 2019

CO$_2$ flow: 1,588 scfm
H$_2$S inlet: 6,700 ppm
H$_2$S outlet: 30 ppm

Vinkel Bioenergy in Denmark delivers more than 5,000 Nm$^3$/hour of natural biomethane to the Danish natural gas grid, i.e., slightly more than 45,000,000 Nm$^3$ of biomethane every year.
Removal of H$_2$S from CO$_2$

Example
The advantages of biological desulfurization

The H₂S removal process is 100% free of chemicals and OPEX are only 10-20% of chemical gas cleaning systems.

Just comparing alternative technologies on CAPEX doesn’t make sense – when you include OPEX for the lifetime of your project biological H₂S removal is much more cost effective than chemical gas cleaning.

The only residue from the process is a sulfur rich fertilizer which can be recycled together with the treated waste water supplementing or replacing industrial fertilizers.

- CAPEX and OPEX for biological and chemical gas cleaning
Performance guarantee

In this project Biogasclean guaranteed max. 80 ppm H₂S in the clean gas. The performance was measured over 6 months. The outlet did never exceed the guaranteed max. 80 ppm H₂S.
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### References

300 references in 40 countries

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<th>Substrate</th>
<th>Typical H₂S load ppm</th>
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<td>Animal waste</td>
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<td>Cassava waste water</td>
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<td>5</td>
<td>Ethanol distillery - molasses</td>
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<td>6</td>
<td>Food industry waste water</td>
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<td>Paper &amp; pulp</td>
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36 references in 16 countries

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<td>Total</td>
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**Client:** Nature Energy, Korskro

**Sector:** RNG - Grind injection

**Location:** Esbjerg, Denmark

**Year:** 2018

**CO₂ flow:** 1,176 scfm

**H₂S inlet:** 8,000 ppm

**H₂S outlet:** 50 ppm

Production of 22 million m³ (777 million scf) CH₄ per year - The CO₂ is utilized in breweries for softdrinks
Client: Clarke Energy
Enduser: MMPA, Hometown Bioenergy
Sector: WWTP
Location: Minnesota, USA
Year: 2013

Biogas flow: 2,294 scfm
H$_2$S inlet: 2,500 ppm
H$_2$S outlet: 200 ppm
Client: Interstate Power System
Enduser: St Cloud, Minnesota
Wastewater Treatment Facility
Sector: WWTP
Location: Minnesota, USA
Year: 2016

Biogas flow: 295 scfm
H$_2$S inlet: 1,600 ppm
H$_2$S outlet: 75 ppm
The mission of Biogasclean is to contribute to the transformation from fossils fuels to renewable energy by innovative and efficient production of biogas.

100% biological. Why destroy the green image of biogas with chemical desulfurization? Biogasclean can do the job without ferric chloride, caustic soda, iron sponge or activated carbon.

Guaranteed performance. Biogasclean’s H₂S removal systems operate efficient and robust and performance guarantees are offered on all projects.

High availability. The uptime of a Biogasclean system exceeds 98%.

Low operating costs provides the most economic solution. When considering both CAPEX and OPEX biological H₂S removal is much more cost effective than chemical gas cleaning.

Elimination of odors and corrosion from biogas. Biogasclean can handle any biogas flow and sulfur load without use of chemicals on both CHP and RNG projects.
Questions

Questions?

The key to innovative and efficient production of biogas