

# Biogas Plant Solutions



3D Model HVC Middenmeer

## Product Definition

**Biogas is produced when biological waste, manure or another waste stream is fermented or turned into bio-synthesis gas via gasification processes. Unfortunately, biogas normally contains a large amount of contaminants that need to be removed. Frames offers a range of smart technologies for efficient removal of these contaminants.**

## Product Description

Frames is globally renowned for supplying the upstream oil and gas market with sustainable, reliable and high-quality systems since 1983. We are specialized in the design, construction, supply, installation and commissioning of complete systems for oil, gas and liquid treatment, separation, heat exchange, flow control and safeguarding.

Frames is eager to develop innovative technologies. We provide optimal processing methods for biogas, including the removal of contaminants such as CO<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub> and terpenes from biogas. Additionally, water vapor and the gas need to be upgraded to the user-defined pressure and quality (Wobbe, Dew Point, THT addition).

### Biogas end-products

The most common end-products of biogas are:

- Combined heat and power (CHP)**  
 Removal of H<sub>2</sub>S is required in order to prevent corrosion damage to the gas engine. Prolonging the lifespan of downstream equipment is crucial for optimizing the Total Cost of Ownership (TCO).
- Green gas for local gas transition systems**  
 Converting biogas into green gas is more energy-efficient than CHP, but requires more processing prior to transportation. Green gas can be compressed to required gas distribution network pressure, for instance 8 or 40 barg. High recovery, emission minimization and TCO are the primary challenges.
- Compressed biomethane (CBM)**  
 CBM is already used in the automotive industry for powering buses, light trucks and passenger cars, with possible compressed pressures up to 300 barg. The challenges are equal to those for green gas.
- Liquefied biomethane (LBM)**  
 LBM can be used in low-emission and low-noise combustion engines. Use of biomethane is expected to grow considerably in the coming years, particularly in the heavy-duty vehicle and truck industries.
- CO<sub>2</sub>**  
 CO<sub>2</sub> is often a waste product produced during biogas upgrading. However, it can become a valuable by-product when upgraded to high purity or converted into a chemical. The greenhouse industry consumes significant amounts of CO<sub>2</sub>.

### Biogas treatment technologies

Frames offers a range of effective treatment technologies that meet the above-mentioned demands and challenges involved in removing contaminants from raw biogas and turning it into valuable end-products.

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GGI HVC Location Middenmeer

### LAMINOL® – for removal of H<sub>2</sub>S

Existing sweetening processes such as amine absorption can effectively remove H<sub>2</sub>S, but these processes are not 100% selective with regard to CO<sub>2</sub>. Frames LAMINOL® H<sub>2</sub>S scavenger technology provides a cost-effective alternative for conventional gas/liquid sweetening processes such as amine units or solid dry bed processes to prevent hydrogen sulfide corrosion. Frames LAMINOL® technology can selectively remove H<sub>2</sub>S from CO<sub>2</sub>-rich gas streams to concentrations less than 1 ppm, even at near-atmospheric gas pressure. Our LAMINOL® technology is especially suitable for treating raw biogas with up to 500 ppm (average) of H<sub>2</sub>S, even before it enters the compressor or other parts of the biogas upgrading plant. By completely removing H<sub>2</sub>S early in the biogas treating process, corrosion, safety and operational expenditures are significantly reduced in the rest of the biogas plant. Even at H<sub>2</sub>S concentrations above 15,000 ppm, LAMINOL can remove all H<sub>2</sub>S with very high efficiency, making it an ideal solution for biogas streams that are affected by incidental high H<sub>2</sub>S peaks.



Close-up of GGI

### GALLOXOL® – for removal of CO<sub>2</sub>

Amine absorption can effectively remove CO<sub>2</sub> from biogas. GALLOXOL® is a second-generation CO<sub>2</sub> removal technology that combines the desirable properties of a primary amine with the neglectable volatility and high stability of a salt. The GALLOXOL® solvent is biodegradable and safe to handle. Use of GALLOXOL® results in a cost-effective solution, with reduced environmental impact and improved CO<sub>2</sub> quality compared to generic amine solutions.



Gas Dehydration at GGI

### PLURISOL® – for removal of VOC, H<sub>2</sub>S, CO<sub>2</sub> and NH<sub>3</sub>

PLURISOL® technology consists of a physical solvent solution which combines several process steps in a single unit operation. Next to drying, the removal of H<sub>2</sub>S, CO<sub>2</sub>, NH<sub>3</sub> and VOC in one process step. Although some selectivity between H<sub>2</sub>S and CO<sub>2</sub> is possible, PLURISOL® technology is not very selective, which is why it is combined with an off-gas processing step based on thermal oxidation. In addition, a combination with bulk H<sub>2</sub>S pre-removal using LAMINOL® treatment, biological systems or liquid redox may be required for streams with constant medium to high loads of H<sub>2</sub>S.

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### PSA (Pressure Swing Adsorption) – for ultra-deep removal of VOC, H<sub>2</sub>O, H<sub>2</sub>S, CO<sub>2</sub> and NH<sub>3</sub>

Most contaminants are removed during the CO<sub>2</sub> washing and drying step. However, a small yet impermissible concentration of contaminants, like terpenes, may be still present in green gas after treatment. Terpenes may interfere with THT green gas odorization and need to be removed before the green gas can be delivered to the gas pipeline. Frames supplies an energy-efficient PSA system that removes terpenes below ppm level.

### Total biogas plant solutions

Thanks to long-standing cooperation with digester suppliers and third parties, Frames can provide complete solutions for total biogas upgrading installations. When required, we incorporate third-party operational units into an integrated total biogas upgrading solution. Frames always ensures that solutions are fully automated, built to high quality and safety levels, and extensively documented.

## Process Description

### LAMINOL®

In a typical LAMINOL® installation, raw gas contaminated with H<sub>2</sub>S is fed into the top of a packed column, along with LAMINOL® solvent. Both gas and liquid move from the top to the bottom through the column while the H<sub>2</sub>S is being absorbed. The scrubbing liquid is collected in a sump, from where it is pumped back to the top of the packed column by a screw pump.

### GALLOXOL®

In a GALLOXOL® installation, CO<sub>2</sub>-rich biogas is washed counter-currently with an activated amino acid solution. The biogas is fed from the bottom of an absorption column, removing CO<sub>2</sub> along its path upwards in the column. CO<sub>2</sub>-lean biogas leaves the top of the absorber. Very deep CO<sub>2</sub> removal is already possible at very low gas pressure. The activated amino acid solution is continuously regenerated using heat, which releases concentrated CO<sub>2</sub>. After regeneration, the activated amino acid solution is returned to the absorber to be reused. Correct selection of biogas upgrading unit operations makes it possible to produce very pure and concentrated CO<sub>2</sub>, which can have additional value.

### PLURISOL®

Physical PLURISOL® solvent is fed into the top of the absorber, where a pressurized biogas stream entering from the bottom of the absorber is washed counter-currently. The typical layout of PLURISOL® is aimed at drying the biogas as well as removing multiple components such as CO<sub>2</sub> and VOC. By releasing the pressure and some minor heat input, the physical solvent is regenerated and pumped back to the top of the absorber column. The released vapor containing CO<sub>2</sub>, H<sub>2</sub>O and VOC is fed to an overhead vapor combusting (OVC) unit. The OVC uses this waste stream and a minor amount of methane to produce the heat required for the regeneration of the physical solvent.

### PSA (Pressure Swing Adsorption)

A PSA unit is placed after the drying step and before THT addition. The PSA cycle operates between two pressures, adsorbing impurities at the higher pressure and desorbing them at the lower pressure with no temperature change, except the change due to the heat of adsorption and desorption. The gas that is produced during the low-pressure purge operation is rich in volatile terpenes and recycled to the raw biogas compressor. These recycled terpenes are subsequently removed during the CO<sub>2</sub> washing and drying step and sent to a thermal oxidation unit.

### Green gas metering and control

When upgrading biogas to green gas, strict requirements apply for injection of the upgraded biogas into local gas grids. Working together with the local gas grid operator, Frames integrates advanced metering systems, THT injection, flow and pressure sensors into the green gas metering and rejection skid. The purpose of this skid is to ensure that injected green gas meets the gas quality targets set by the gas grid operator, regulator or government.

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# Biogas Plant Solutions

## Project Management

Good project management is like running a busy family – directing and coordinating all efforts in order to optimize the result of the team.

At Frames, we work as a coordinated team that focuses on integrated solutions. Our multidisciplinary teams ensure smooth integration of own Frames technology unit operations and technologies provided by partners or subcontractors into a total biogas processing solution. The combination of our project management system and the skills of our project managers ensures that we deliver the equipment for each project on time, while paying particular attention to health, safety, environment and quality requirements for both the client and Frames.

Thanks to a network of international partners and a worldwide supply chain, our clients benefit from smart services provided by a strong, global project management company.

## Technical Details

- **Efficient, cost-effective technologies for removal of CO<sub>2</sub>, H<sub>2</sub>S, VOC and NH<sub>3</sub>**
- **Green gas compressor systems**
- **Liquefied bio-methane units**
- **Fast commissioning for advanced cash flow**
- **Full compliance with international safety and environmental standards**
- **Simple commissioning and years of trouble-free operation**

## Added Value Frames

- **Proven solutions and processes built to match unique gas composition and operating conditions**
- **Cutting-edge technical designs, with computerized 3D modeling for previews of any project detail**
- **Complete service portfolio including construction supervision, operator training, site installation, consultancy, reliability and availability management, and spare parts management**
- **24/7 worldwide service and after-sales support**

## References

- **HVC Middenmeer – the Netherlands**

## Contact

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