



APPLICATION NOTE

MEASURING BIOGAS COMPOSITION

Biogas composition

The composition of biogas depends on the nature of the organic matter being digested and the process design. The main components are methane (50 - 75% vol) and carbon dioxide (25 - 45% vol) but several other components also exist in the biogas. Table 1 lists the typical components in biogas.

Table 1. Composition of a generic biogas

Components	Components concentration in a generic biogas
Methane (CH ₄)	50-75% du vol.
Carbon dioxide (CO ₂)	25-45% du vol.
Water (H ₂ O)	2-7% du vol.
Hydrogen sulfide (H ₂ S)	20-20000 ppmv
Nitrogen (N ₂)	< 2% du vol.
Oxygen (O ₂)	< 2% du vol.
Hydrogen (H ₂)	≤ 1% du vol.

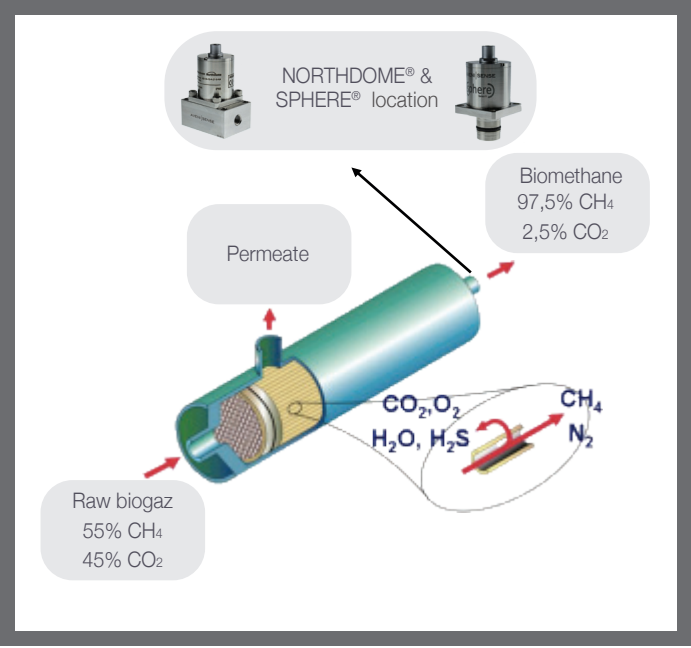


Figure 1. NORTHDOME® location in a membrane biogas purification plant

Production and upgrading of biogas

Biogas is the byproduct of anaerobic digestion of organic matter. This process naturally occurs in swamps, spontaneously in landfills or can be induced in digesters processing organic matter. Biogas is a renewable energy source that can be a substitute for natural gas. Biogas can replace natural gas if it reaches a minimum methane content of at least 96.5%. This can be achieved in a purification process where H₂S, CO₂ and siloxanes are removed. Several technologies for biogas upgrading are commercially available and others are at the pilot or demonstration level. Figure 1 shows the membrane purification process. These membranes are made of polymer material which shows good selectivity in the separation of methane and CO₂ with some robustness to trace compounds contained in the crude biogas.



Measuring Binary Gas Concentration using NORTHDOME®

The concentrate from the membrane is basically a binary gas mixture of methane and carbon dioxide. NORTHDOME® measures gas density and temperature, SPHERE® measures absolute gas pressure. Combining these measurements with the ideal gas law in a separate computing system allows the calculation of the molar mass of the mixture. The measurement has been expensive and complex using traditional analysis techniques like a gas chromatograph. Gas density is a very straightforward approach to binary gas measurement. This measurement gives us information of the percentage of methane and carbon dioxide contained in the biogas outlet of the purification stage. NORTHDOME® is the enabler to proof that the biogas meets the necessary specification for the injection into the natural gas network.

Density measurement

After the upgrading of biomass, one of the key issues is to know the methane content in the biogas in order to use it as a renewable substitute for fossil natural gas. NORTHDOME® sensor allow us to determine biogas density and deduce its methane content. Figure 2 shows the measurement of a binary gas of methane and carbon dioxide using NORTHDOME® using laboratory prepared mixtures of different concentrations carbon dioxide in methane. You can see from this figure the resolution of CO₂ content, which is heavier than methane, and increases the mixture's density. With only a 7% CO₂ concentration, the density of methane increases 100 g/m³. Density, pressure and temperature measurements can be used to calculate molar mass and also its methane contents as we can see in Figure 3.

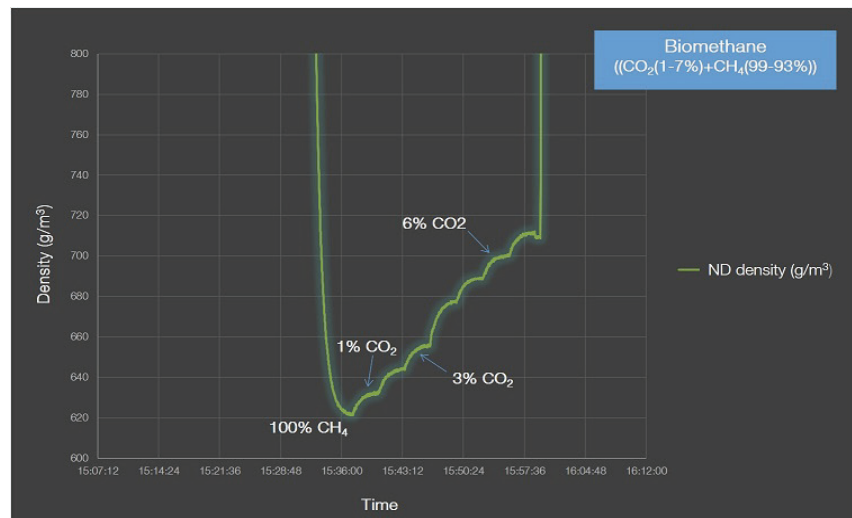


Figure 2. Measured density of a CO₂-CH₄ mixture by NORTHDOME® sensor

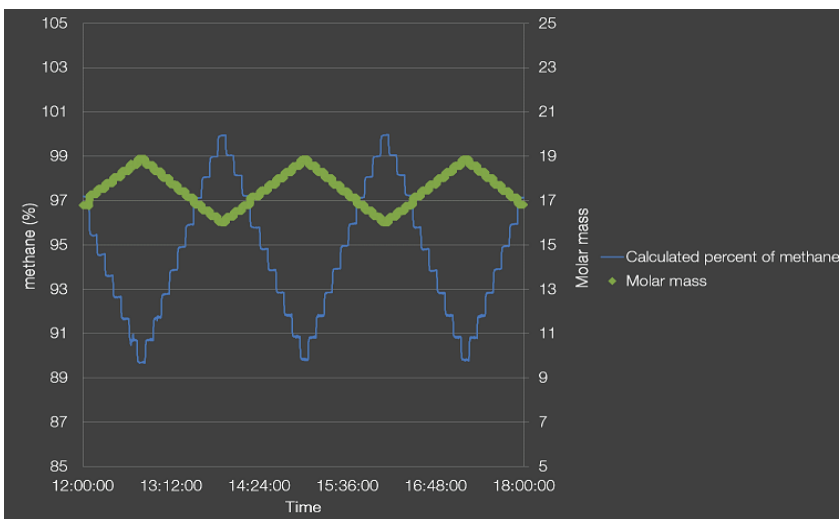


Figure 3. Measured molar mass by NORTHDOME® sensor and calculated percent of methane

SUMMARY

Anaerobic digestion of biomass results in the production of biogas. After the purification process we can obtain methane. It can be used as a renewable substitute for fossil natural gas. NORTHDOME® sensor provides a simple and robust method for determining methane concentration to confirm the gas meets pipeline quality standards.