

New biogas upgrading techniques

2nd Nordic Biogas Conference

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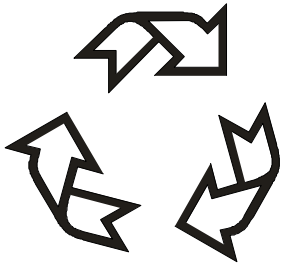
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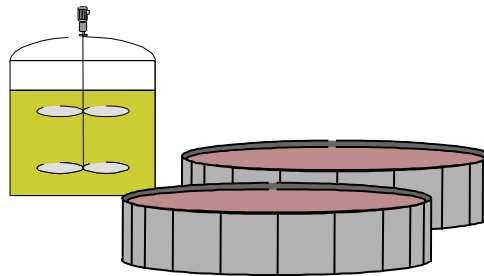
Biogas consultancy

27 years experience

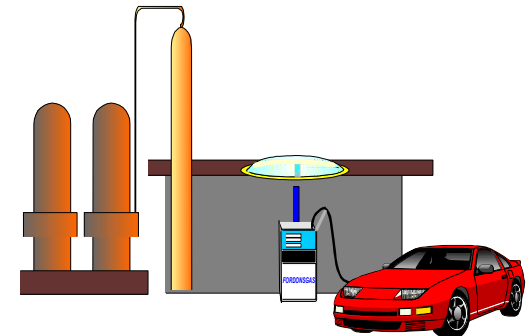
Sustainability



Biogas production



Biogas as vehicle fuel



Biogas upgrading is a technology for purification of biogas to a higher quality

Material:

Digestion biogas	63	%	methane
	33	%	carbon dioxide
	1	%	nitrogen
	3	%	water
			hydrogen sulphide

Landfill gas	50	%	methane
	35	%	carbon dioxide
	14	%	nitrogen
	1	%	water
			hydrogen sulphide
		siloxanes	

Product:

-Vehicle fuel according to Swedish Standard type B:
95 - 99 % methane
< 5 % carbon dioxide, nitrogen, oxygen
< 1 % oxygen
a low water content, dp -60°C

-Vehicle fuel according to the vehicle certification system, >86 % methane (reference fuel G25)

-A heating value corresponding to the gas quality in the natural gas grid. Propane addition may be necessary.

-LBG

-CO₂(l) or CO₂(s)

Conventional ways to reach biogas quality demands

Upgrading of digestion biogas with

- PSA
- Water scrubbing
- Amine wash

What needs could new biogas upgrading techniques satisfy?

- Lower investment and operational costs
- A methane product with logistic advantages (LBG)
- A carbon dioxide product
- Upgrading of landfill gas
- Appropriate small scale biogas upgrading

Overview of new biogas upgrading techniques mentioned today:

- Membrane technique
98 % methane content from recently built plant in Austria

- Cryogenic upgrading
LBG production
Landfill gas upgrading
CO₂ recovery

- Innovations for small scale upgrading

Membrane technique

Demonstration plant in Bruck/Leitha, Austria, in continuous operation since October 2007.

System from Axiom and TU Wien

Membranes delivered by Air Liquide

180 Nm³/h raw biogas capacity

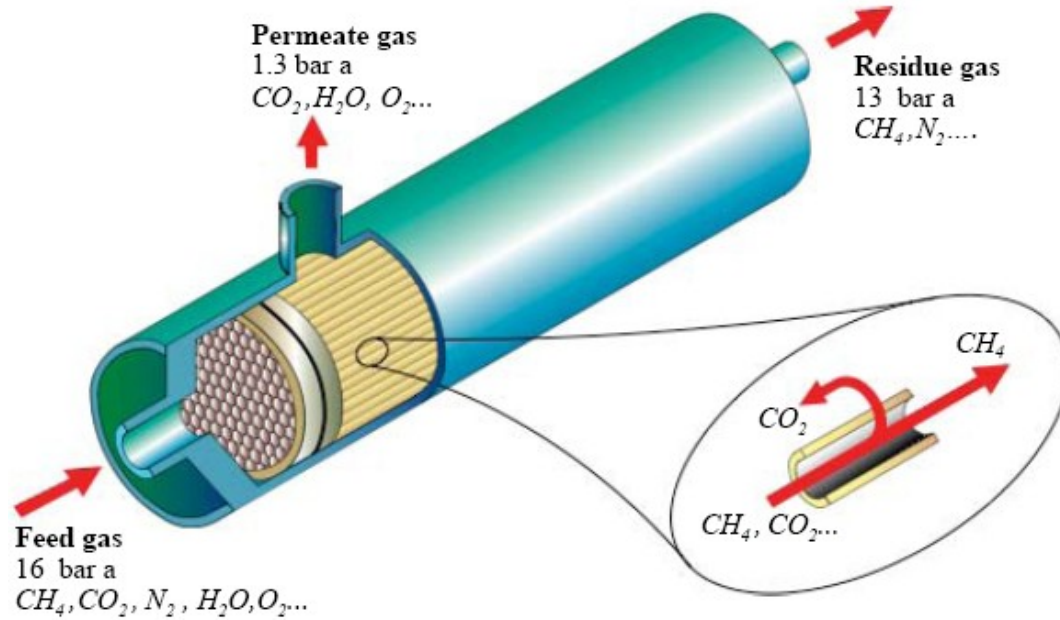
Old technique, but essential modifications

The technique is interesting if the membrane vent gas can be lead to a CHP. Approximately <5 % methane losses



Source: 2nd Generation Biodiesel and Biogas as a Fuel – Research Activities of a Mineral Oil Corporation
Walter Böhme, Head of Innovation OMV AG, Berlin, 27.11.2007

Membrane technique



Source: Medal™ membrane systems for Biogas/Landfill gas, Air Liquide

Advantages

Investment and operational costs?

Easy to switch on/off

High product gas methane content

Disadvantages

Membrane life time?

Not suitable for biogas with many undefined contaminants, like landfill gas or biogas from WWTP.

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Cryogenic upgrading and gas liquefaction

-Gas separation through usage of gases' different boiling and melting points.

	CO ₂	CH ₄	N ₂
Boiling point	-78 °C	-162 °C	-196 °C
Melting point	-57 °C, >5 bara	-183 °C	-210 °C

Cryogenic biogas upgrading characteristics to consider:

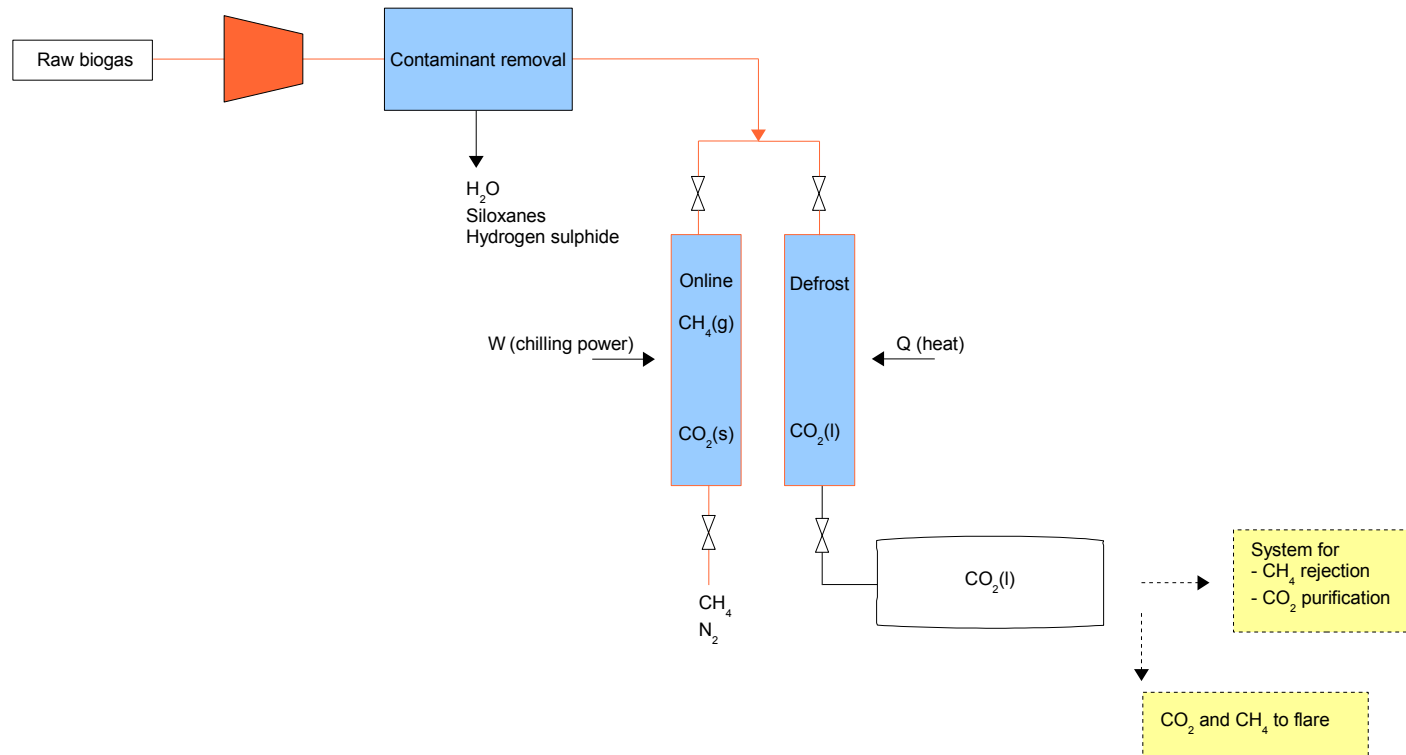
- Methane has a certain solubility in liquid carbon dioxide
- Methane has a low solubility in solid carbon dioxide

Methane liquefaction characteristics to consider:

- The gas flow must not contain carbon dioxide, because of dry ice formation in heat exchangers
- Nitrogen dissolve into the liquid methane. Nitrogen removal from LBG may be necessary

Cryogenic upgrading

Rough schematic *upgrading* principle



Cryogenic upgrading

Prometheus Energy
Frank R. Bowerman Landfill
California

Landfill gas to LBG

In continuous operation since
December 2007

Rejection of N_2 from LBG



Source: Fuelling new ideas, Conversion of biogas into LNG becomes reality, Dan Clarkson, Prometheus Energy

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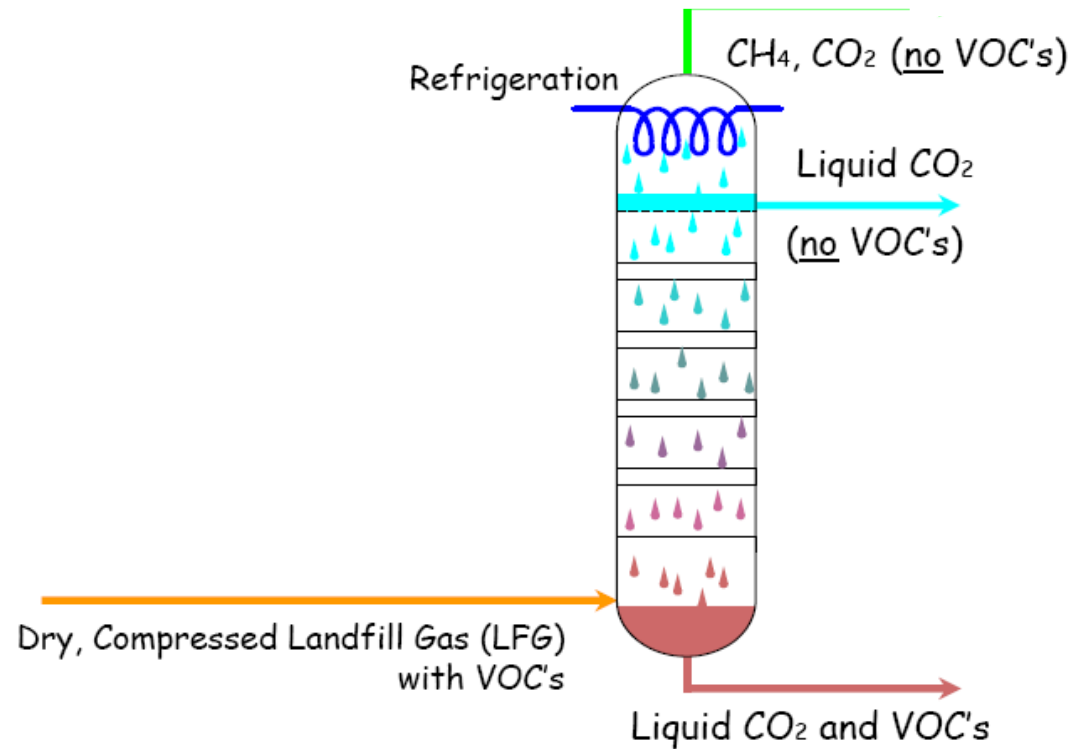
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Cryogenic upgrading

Acrion Technologies Inc
Volvo Technology Transfer is a
licensee

Contaminant removal with liquid
carbon dioxide

Pilot plant in NJ, USA produced
food grade carbon dioxide and
liquid methane (LBG)



Source: Volvo technology Transfer

Small scale upgrading

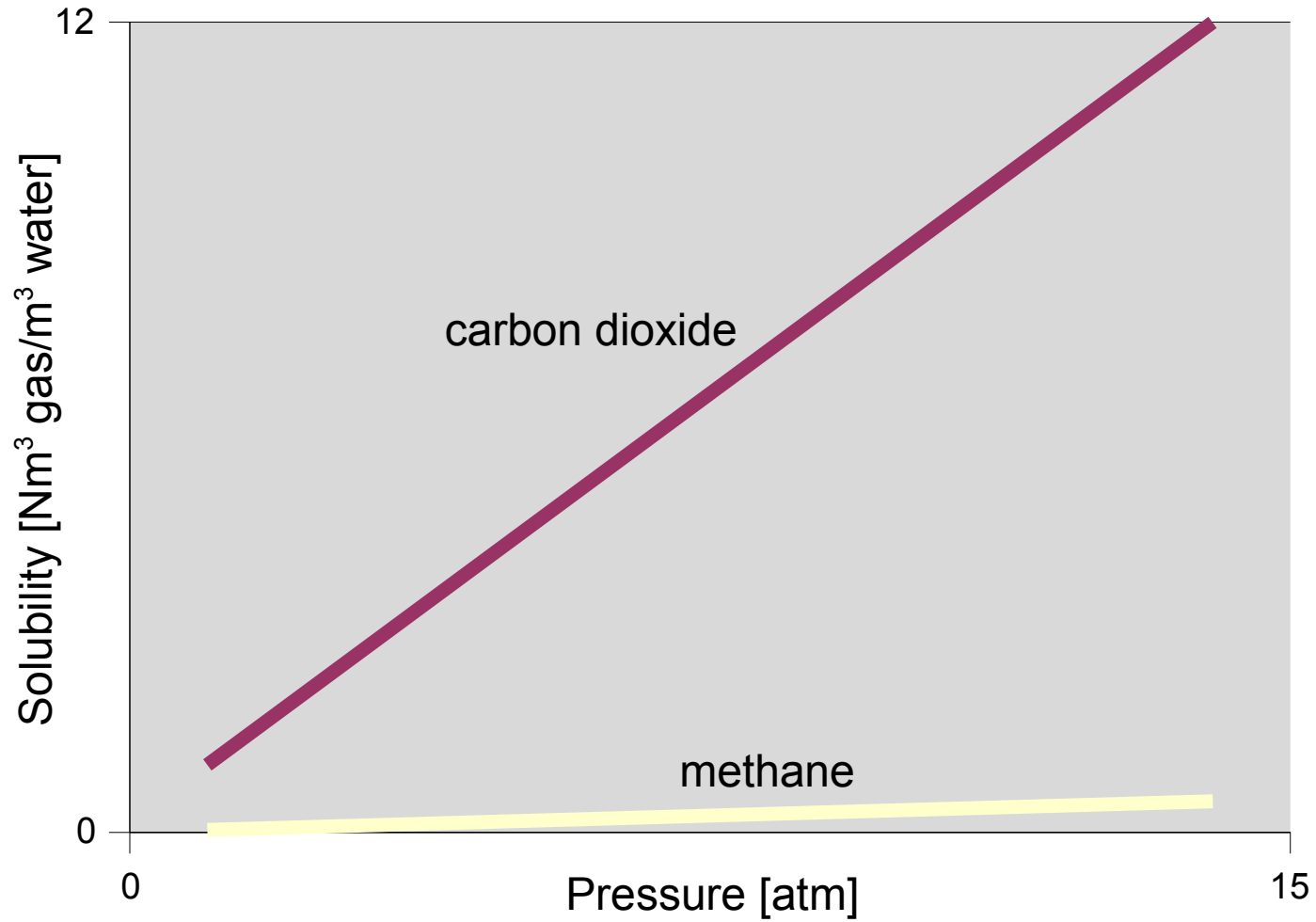
Possibilities:

Water absorption innovations, plenty of water at WWTP

Acceptance of a methane content below 95 vol-% CH₄

Standardised conventional upgrading plants for lower investment cost

Solubility in 20 °C water



Examples av innovators, water absorption

Biorega	Modified water scrubbing technique
Metener	?
JTM Invest	Alternating intake of biogas and water into a pipe under pressure
JTI	In situ methane enrichment

Examples av innovators

JTM Invest AB, Jukkasjärvi

Tested autumn 2007

Usage of a pump for biogas + water



Conclusions -New biogas upgrading techniques:

Promising demonstration plants for biogas upgrading with membrane and cryogenic technique

Cryogenic upgrading gives possibilities for:

- LBG production
- Landfill gas upgrading
- CO₂ recovery

Modified water absorption may be an alternative for smaller WWTP and farms

-A gas quality sufficient for modern OTTO-engines, but not necessary >95 % CH₄

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Thanks for the attention

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