Separation of H_2 from natural gas-H_2 -mixtures

The H_2-Membrane project

Eric Tamaske
Corporate Development

Leipzig, 16th June.2022

ONTRAS Gastransport GmbH

ONTRAS Gastransport GmbH is a nationwide natural gas transmission operator in the European grid system.

2006
Foundation

379
Employees

Headquarter
Leipzig
+ 13 locations

ONTRAS Gastransport GmbH

7.700 km
High-pressure pipelines

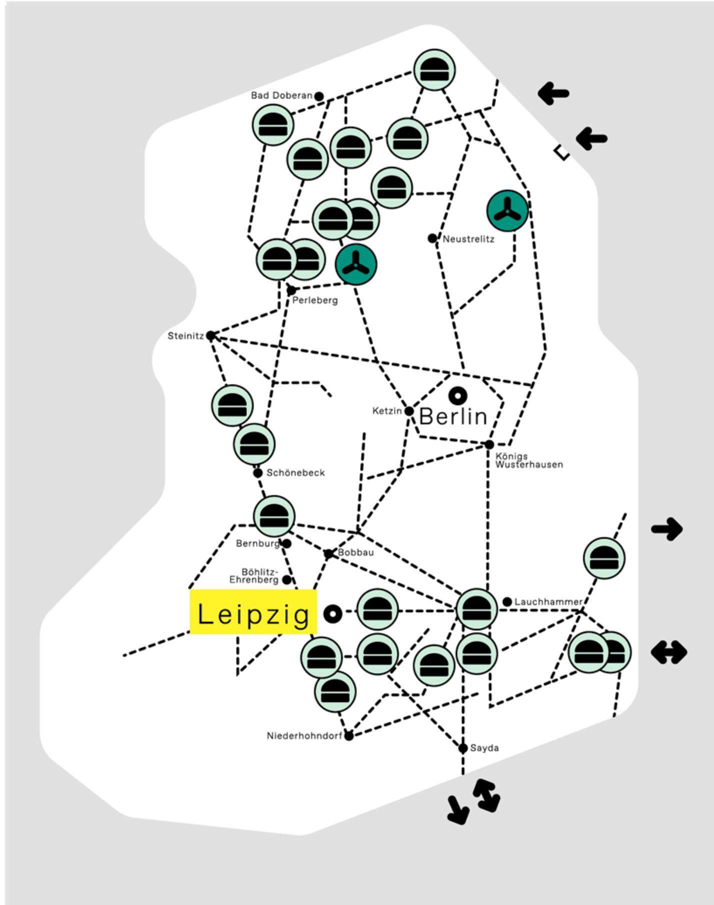
442
Network interconnection points

6
Stores connected to the network

130
Downstream network operators (grid area)

23
Connected biogas plants

2
Connected power-to-gas plants



Feed-in from Power-to-Gas Facilities into the network of ONTRAS

Hybridkraftwerk Prenzlau

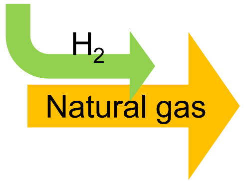
- Operated by ENERTRAG AG
- Power connection: 500 kWel
- H_2-production: 120 m³/h
- Blending with natural gas in the ONTRAS system

WindGas Falkenhagen

- Operated Uniper SE
- Power connection : 2.000 kWel
- H_2-Production: 360 m³/h
- Additional methanation in operation since 2018

Background and motivation

- Power-to-Gas uses the existing natural gas infrastructure
- We see a parallel development – dedicated pipeline and H_2-blending
  - Options for a coexistence of natural gas and hydrogen necessary
- Limitations for H_2 on the demand side of the natural gas infrastructure
  - CNG-filling stations: < 2 mol-%
  - Existing gas turbines: varying (between 1 - 4 mol-%)
  - Industrial applications: limits are under discussion, but steady H_2-concentration is aspired
- Necessity of H_2/natural gas mixtures
  - 10 mol-% H_2 in the natural gas grid in Germany permitted, higher limits in discussion
  - > 20 mol-% H_2 potential future limit with replacements of application technology

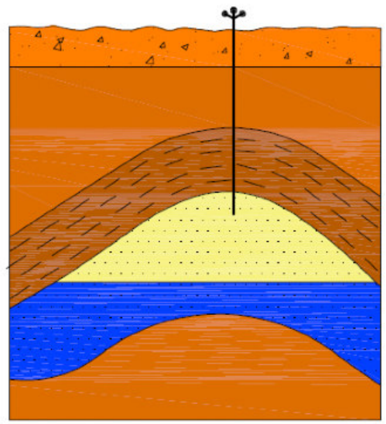


Need for H_2-treatment on pore storage facilities

Gas storages

- Caverns and pore storage facilities largely in use in Europe
- 75 % of the storages in Europe are pore storages
- In Germany most of the storage capacity in caverns
- On the long run, we need all the useful storage capacity for H_2
- When you convert a natural gas storage, you will have H_2/natural gas mixtures with variable composition over years

Treatment of the H_2/natural gas mixture necessary



Source: UGS GmbH

Separation technologies hydrogen/natural gas - Overview

Membranes

- Various materials (polymer, inorganic or palladium-membranes) under investigation in a laboratory scale
- Different materials are suitable
- For the specific use H_2/natural gas no facility in in operational environment

Adsorption

- Under given conditions an adsorption of H_2 not feasible
- adsorptive separation is economically relevant in concentrations from 50 % H_2 and higher

Chemical transformation

- **Catalytic methanation of H_2** – Alternative for protection of facilities
- **Oxidation** – chemical reaction of H_2 with oxygen into water – feasible, but H_2 is annihilated

Miscellaneous

- Cryogen H_2-separation technically feasible

Membrane techniques, methanation and oxidation basically feasible

More details see DVGW R&D project: *Anforderungen, Möglichkeiten und Grenzen der Abtrennung von Wasserstoff aus Wasserstoff/Erdgasgemischen* (G 201611)

Advantages of membrane techniques

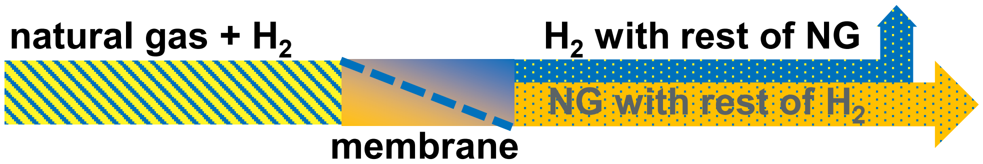
- Little complexity
- Low OPEX
  - Main “feed stock” pressure – available in gas networks
  - Works mostly under ambient temperature conditions
- Flexibility
- No by-products (disposal of waste)
- No chemicals necessary
- Different materials available (R&D)
- Compactness

Surrounding conditions for membrane techniques

- For facilities with a smaller scale the costs for the membranes are secondary (mainly costs for installations)
- Costs depend on different conditions (pressure, number membrane stages, desulphurization...)
- OPEX are dominated by compressor usage
- H_2 – purity > 99,9 % possible with Pd-membranes; other membranes 96 – 98 %
- More details to costs, see DVGW R&D project DVGW G 201611

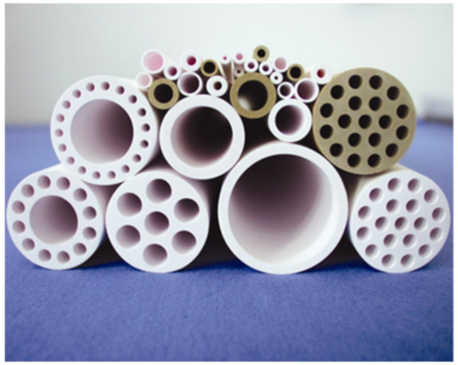
Pilot facility for membranes in Prenzlau

- Existing ONTRAS-Feed-in facility for Hydrogen
- Pressure: max. 25 bar
- Hydrogen concentration variable from 0 to 50 Vol.-%, fixed rate in every experimental run
- Volume flow from 1 to 2 m³ mixture per hour



Partners

- DBI Gas- und Umwelttechnik GmbH
- ONTRAS Gastransport GmbH
- GRTgaz S.A. Forschungszentrum RICE, France
- Mitteldeutsche Netzgesellschaft Gas mbH
- DVGW Deutscher Verein des Gas- und Wasserfaches e.V.
- Associate partner: ENERTRAG AG

Source: Fraunhofer IKTS

Pilot facility for membranes in Prenzlau

Pilot facility for membranes in Prenzlau

Pilot facility for membranes in Prenzlau

- Online monitoring of gas quality by using gas chromatography
- Remote supervision and control by DBI from Leipzig

Test strategy

Membrane types	Status quo
Polymer membrane	Membranes in testing
Inorganic membranes	Membranes at hand / in preliminary investigation in the laboratory
Inorganic membranes (molecular sieve)	Membranes at hand / in preliminary investigation in the laboratory
Pd-membranes	Matching of test conditions with the manufacturer
…	…

Test procedure

	Desciption	Duration in days	Conditions
1	Polymer membrane number 1	3	H_2/NG 10/90 Pressure ca. 20 bar
2		2	H_2/NG 10/90 Pressure ca. 10 bar
3		2	H_2/NG 20/80 Pressure ca. 20 bar
4		2	H_2/NG 20/80 Pressure ca. 10 bar
5	Stability test: replication of test number 1	2	H_2/NG 10/90 Pressure ca. 20 bar
6	Simulation of a second membrane stage	3	H_2/NG 50/50 Pressure ca. 20 bar

First results

Accelerated test in Prenzlau

- Polymer membrane with an mixture of H_2/NG 10/90
  - H_2 > 40 mol-% in permeate, second stage necessary for higher purity

New results from the laboratory tests

- With carbon membranes hydrogen level can be raised from 98 mol-% (DVGW G 260 : Group A) to 99,97 mol-% (Gruppe D) → seems to be feasible

General remarks

- Pd-Membranes are able to extract very pure hydrogen (> 99,97 – mol-%) under stable conditions (tests in Spain)

Thank you very much for your attention, please feel free to ask your questions!

ONTRAS

Eric Tamaske

Tel: +49341 27111-2386 |
E-Mail: eric.tamaske@ontras.com