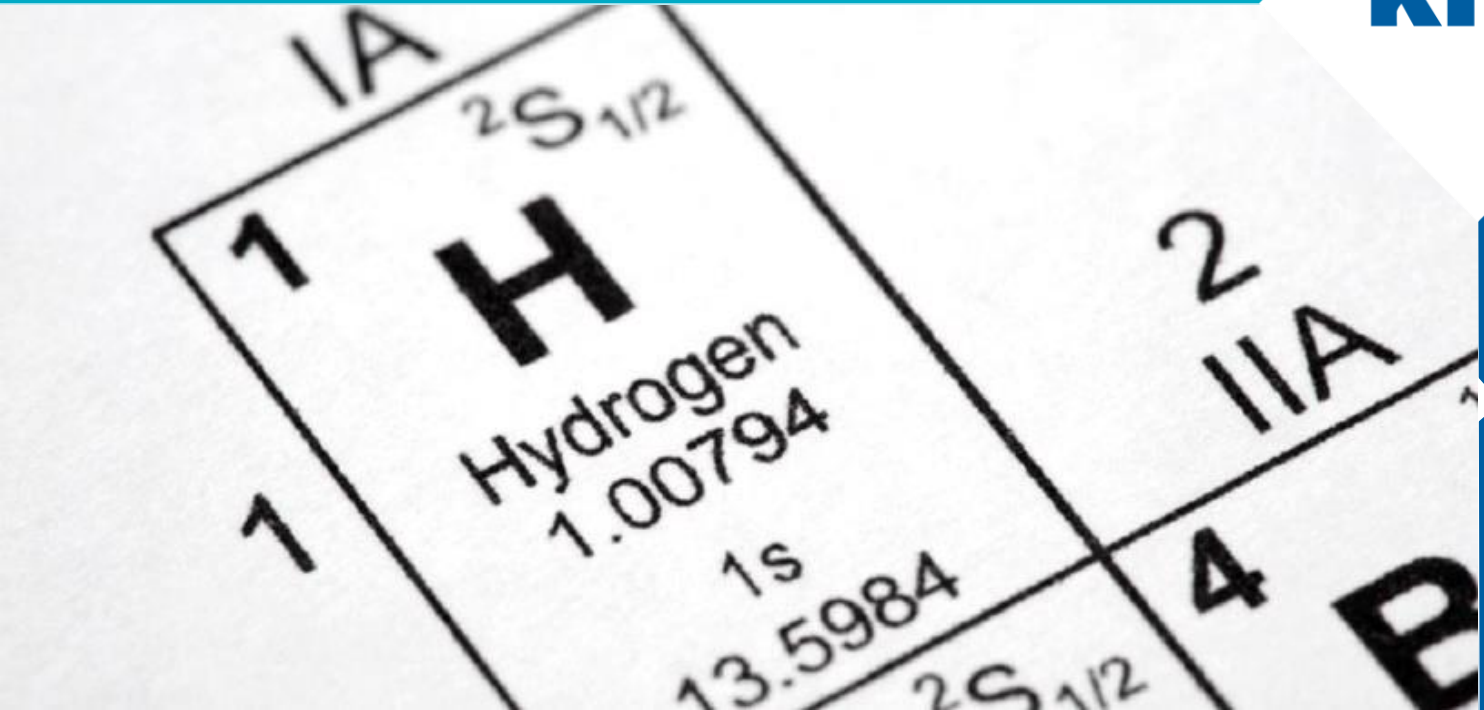
PE pipes for hydrogen transport

Pipe customer event LyondellBasell



Kiwa Technology B.V.

Partner for Progress

Introduction

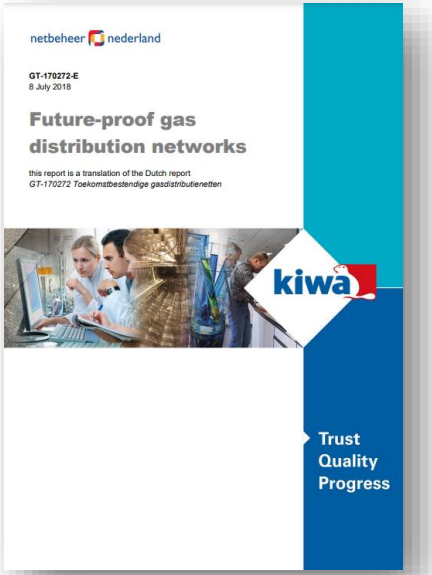
Hydrogen transport in the Netherlands: current progress

PE is chemically resistant to hydrogen and no decrease in lifetime is to be expected.

Future-proof gas distribution networks

Switching from natural gas to the sustainable gases

- Resistance of current gas distribution network hydrogen?
- Adjustments needed to current gas networks?
- Costs involved in the changeover?

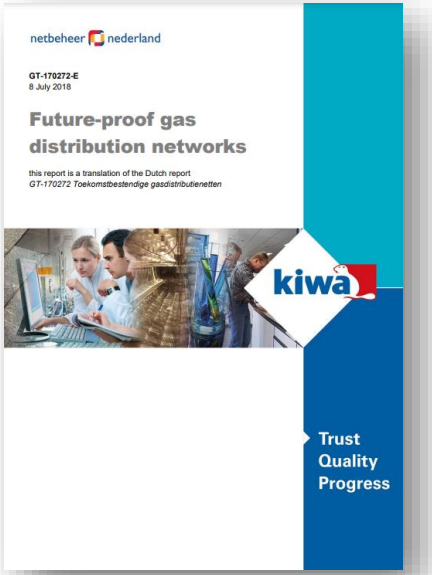


Netbeheer Nederland

Future-proof gas distribution networks

Conclusions:

- The gas distribution network is resistant to hydrogen.
- Safe and reliable distribution in the built environment is possible.
- Costs operator/customer are limited compared to alternatives.
- Existing devices are not simply suitable for 100% hydrogen.
- Requirement for revision of standards, work instructions, training of engineers and other professionals.

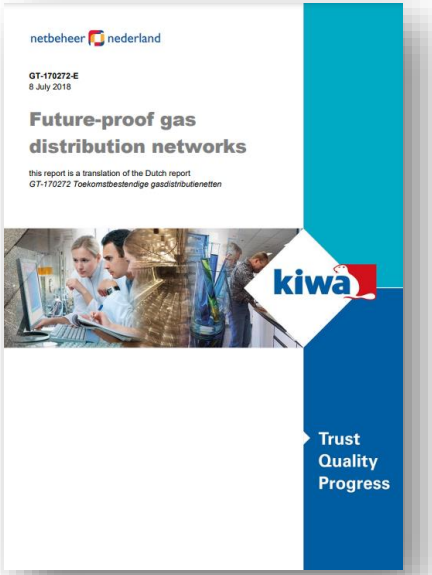


Netbeheer Nederland

Future-proof gas distribution networks

Conclusions:

- The gas distribution network is resistant to hydrogen.
- Safe and reliable distribution in the built environment is possible.
- Costs operator/customer are limited compared to alternatives.
- Existing devices are not simply suitable for 100% hydrogen.
- Requirement for revision of standards, work instructions, training of engineers and other professionals.



https://www.netbeheernederland.nl/dossiers/waterstof-56/documenten

Hydrogen transport pilot projects

Netbeheer Nederland

1 North Sea Wind Power Hub
Eiland in de Noordzee 2030 - 2050
Elektrolyse voor transport van waterstof naar land.
TenneT, Gasunie

2 Entrance terrein Hanzehogeschool
Groningen 2019 - 2020
Test waterstofnet inclusief waterstof cv-ketels.
RENDO NETWERKEN, coteq

3 Waterstofwijk Wagenborgen
Wagenborgen 2020 - 2030
30-40 bestaande woningen verduurzamen middels hybride warmtepomp op waterstof.
ENEXIS NETBEHEER

4 Waterstofpilot H2 Oosterwolde
Oosterwolde 2021 - 2026
Waterstof voor inpassen van grootschalige zonne-opwek.
alliander

5 Waterstofpilot Hoogeveen
Hoogeveen 2020 - ∞
H_2 toepassing in bestaande infrastructuur en gebouwde omgeving.
RENDO NETWERKEN, Gasunie

6 Tijdelijk ombouw Uithoorn
Uithoorn 2020
14 woningen ombouwen van aardgas naar waterstof.
STEDIN

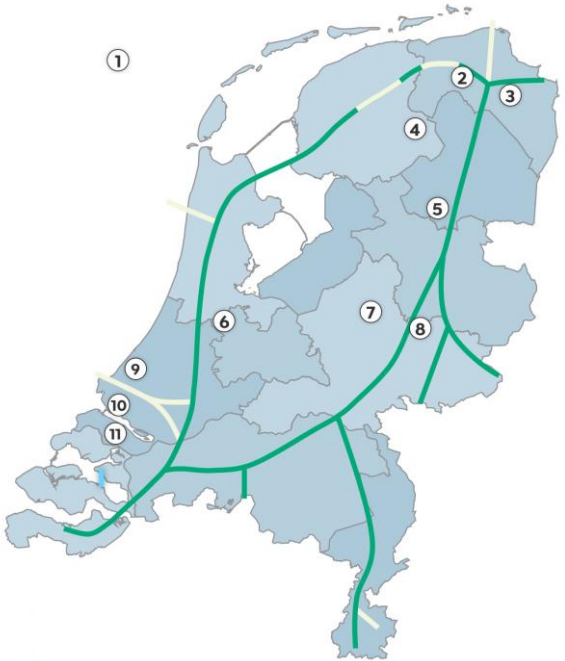
7 Demo- en trainingswoning
Apeldoorn 2020 - 2026
Demo en trainingswoning voor waterstof op het terrein van KIWA.
alliander

8 Waterstofpilot H2 Lochem
Lochem 2022 - 2025
Waterstof als alternatief voor aardgas in monumentale Woningen.
alliander

9 Waterstofpilot The Green Village
Delft 2019 - 2025
Beheren van een 100% waterstofnet.
ENEXIS NETBEHEER, STEDIN, alliander

10 Waterstofpilot P2G
Rotterdam Rozenburg 2013 - 2023
Gesloten waterstofsysteem in de gebouwde omgeving.
STEDIN

11 Waterstofombouw
Stad aan 't Haringvliet 2025 - ∞
Ombouw waterstof in de gebouwde omgeving.
STEDIN, Gasunie



Pilots across the entire chain

Production | Distribution | Build environment | Appliances

HyDelta research program

Public-private partnership and Dutch national research program facilitating the large scale implementation of hydrogen.

HyDelta 1.0 and 2.0 finished, HyDelta 3.0 is about to start.

General research topics in the program

- Hydrogen safety
- Hydrogen in the gas grid
- Value chain & hydrogen admixing
- Economic aspects of the hydrogen system
- Hydrogen & transport assets
- Social aspects of hydrogen

HyDelta research program

- **Research topics already covered**
  - Odorization
  - Piping and indoor installations
  - Emergency shut-off valves
  - Safe operations in the transmission and distribution grid
  - Venting and flaring of hydrogen
  - Purging

- All the reports and output can be found via the website

https://hydelta.nl/

PE pipes for hydrogen

Hydrogen transport in the Netherlands: current progress

PE is chemically resistant to hydrogen and no decrease in lifetime is to be expected.

- Chemical compatibility
- Permeability

EN 1555 series (2021) currently under revision (for H_2)

Chemical compatibility

- Experience
- Practical tests
- Laboratory investigations

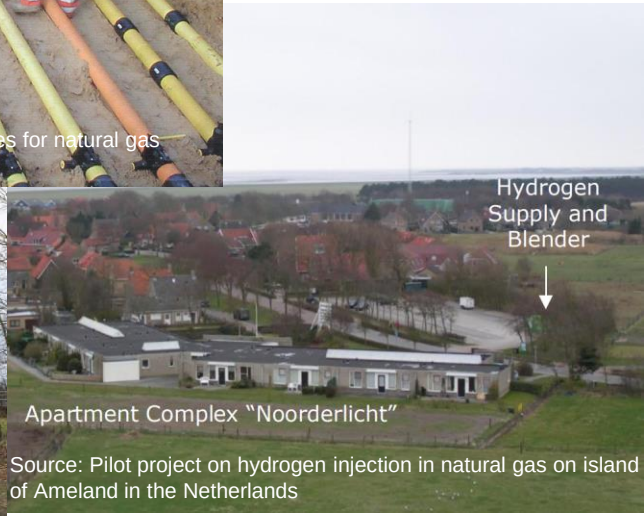
Chemical compatibility

- Experience
  - Hong Kong & China Gas company: ~50% H_2 since 1987
  - Hawai'i Gas: up to 15% H_2
  - Industry, using coke oven gas and town gas: over 40% H_2
- Practical tests
- Laboratory investigations

Chemical compatibility

- Experience
- Practical tests
  - NL: 4 year trial up to 20% H_2
  - DK: 10 year trial 100% H_2
  - DE: multiple projects ranging from 9,9% H_2 up to 100% H_2
  - UK: Two sites with 20% H_2
- Laboratory investigations

Source: Hydrogen transport in polymer pipes for natural gas distribution – Ten years of experience



Source: Pilot project on hydrogen injection in natural gas on island of Ameland in the Netherlands

Source: Avacon – Waserstoff im Gasnetz

Chemical compatibility

- Experience
- Practical tests
- Laboratory investigations
  - At high pressure, up to 100 bar
  - At high temperature, up to 80°C
  - Various periods, up to 13 months

Source: HyDeploy: The UK's First Hydrogen Blending Deployment Project

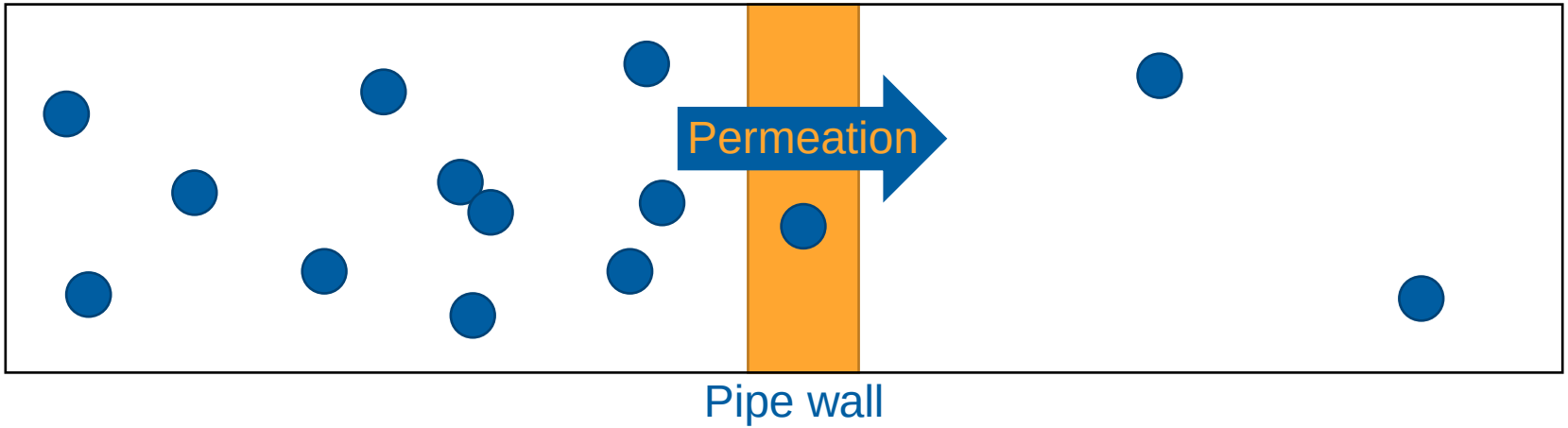

Source: Modern PE pipe enables the transport of hydrogen

Permeation

- What is permeation?
- What are the permeation values for PE pipes?
- How does permeation compare to leakage?

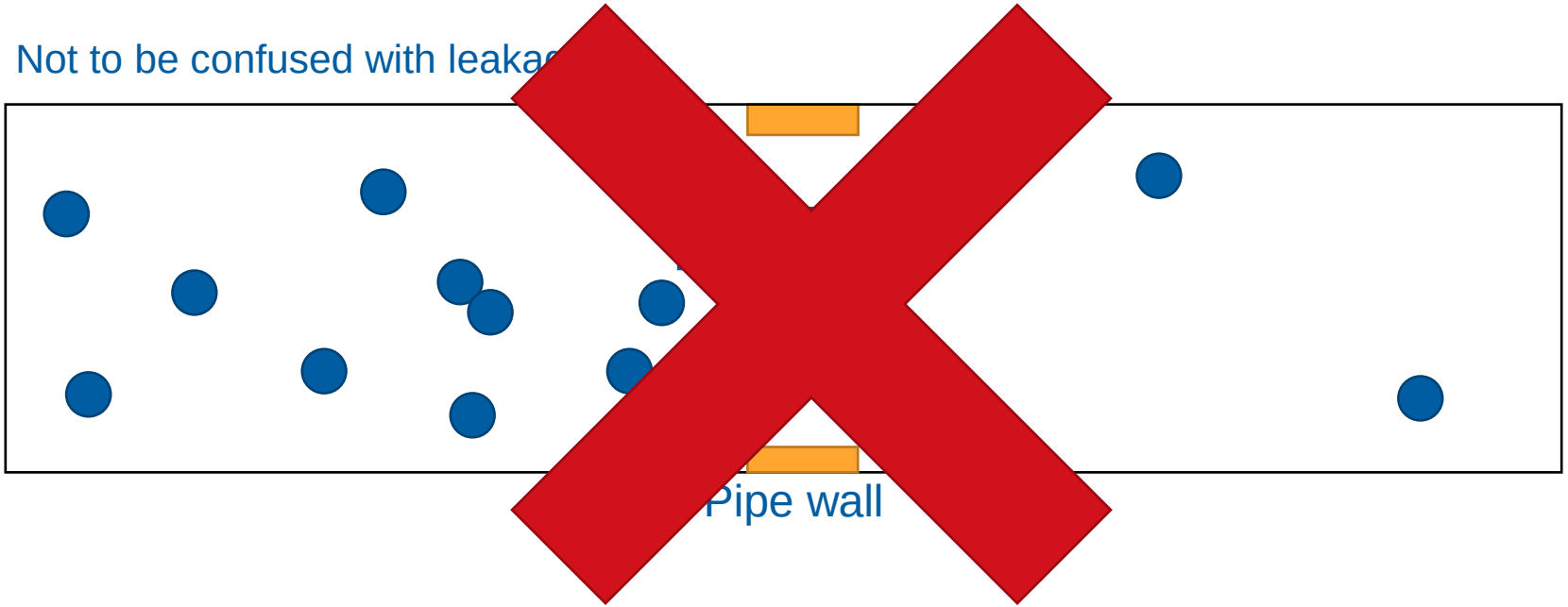
Permeation

- What is permeation?



Permeation

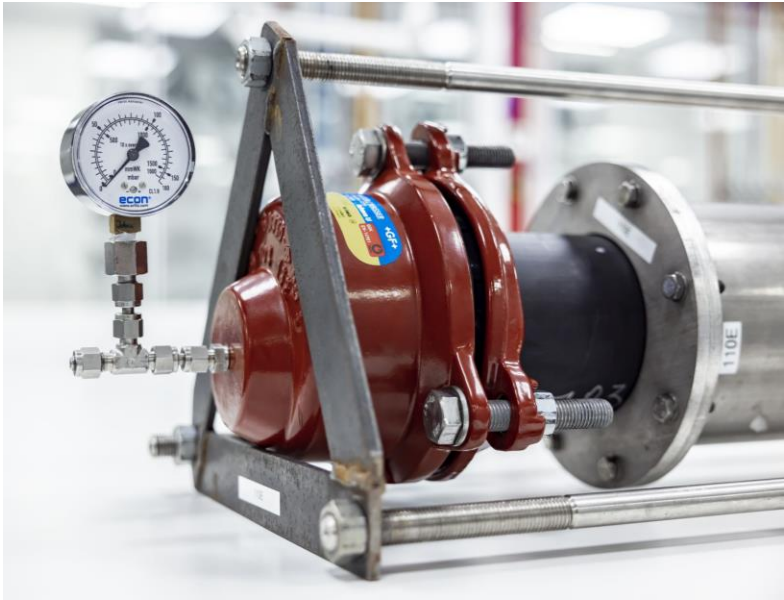
- Not to be confused with leakage



Permeation

Permeation rate dependencies:

- Permeate
  - Gas, liquid, or vapour
- Concentration difference permeate
  - (For gases often expressed as partial pressure)
- Dimensions of the barrier layer
  - Wall thickness, surface area
- Permeability coefficient of the material
- Temperature



Permeation

- What is permeation?
- What are the permeation values for PE pipes?

$$\left[\frac{ml \cdot mm}{m^2 \cdot bar \cdot day}\right]$$

  - MDPE 191-193
  - PE50 143-180
  - PE80 148-167
  - PE100 133-139
  - PE100-RC 125-140
- How does permeation compare to leakage?

Source: https://www.netbeheernederland.nl/_upload/Files/Waterstof_56_59a3ae4674.pdf

Permeation

- What is permeation?
- What are the permeation values for PE pipes?
- How does permeation compare to leakage?
  - MDPE – SDR17,6 – 100mbar → $5 \cdot 10^{-4}$ $dm^3/m/hour$
  - PE100-RC – SDR11 – 8bar → $1{,}6\text{-}1{,}8 \cdot 10^{-3}$ $dm^3/m/hour$

Maximum leak size at a test pressure equal to MOP		
Type of pipe	**Natural gas Max. leak rate [dm^3/h]**	**Hydrogen Max. leak rate [dm^3/h]**
Main pipeline	5.0	5.0
Service pipeline - new*	0.2	0.2
Service pipeline - existing	1.0	0.7
Meter set-up	0.1	0.1

Source: DOI:10.5281/zenodo.5901917 – Recommendation for NEN 7244-7

Stay in touch

Sjoerd Jansma
Consultant Materials
Wilmersdorf 50
7327 AC Apeldoorn
The Netherlands

+31 6 134 70 233
Sjoerd.jansma@kiwa.com
www.kiwa.com

www.linkedin.com/company/kiwa
www.youtube.com/user/Kiwa1948