Hydrogen Device Design with Safety in Mind

How looks the transition to hydrogen?

Who are the potential users of hydrogen?

- Natural gas suppliers
- Petrochemical and chemical companies
- Energy companies
- Iron producers

vexve.com

What's different in design of hydrogen equipment?

- Materials
  - Selection of appropriate materials for hydrogen storage and transport
- Explosion risk
  - Potential hazards and safety measures
- Leakage and leakage detection
  - Methods to detect and prevent hydrogen leaks
- Energy density of hydrogen
  - Efficiency and storage capacity considerations

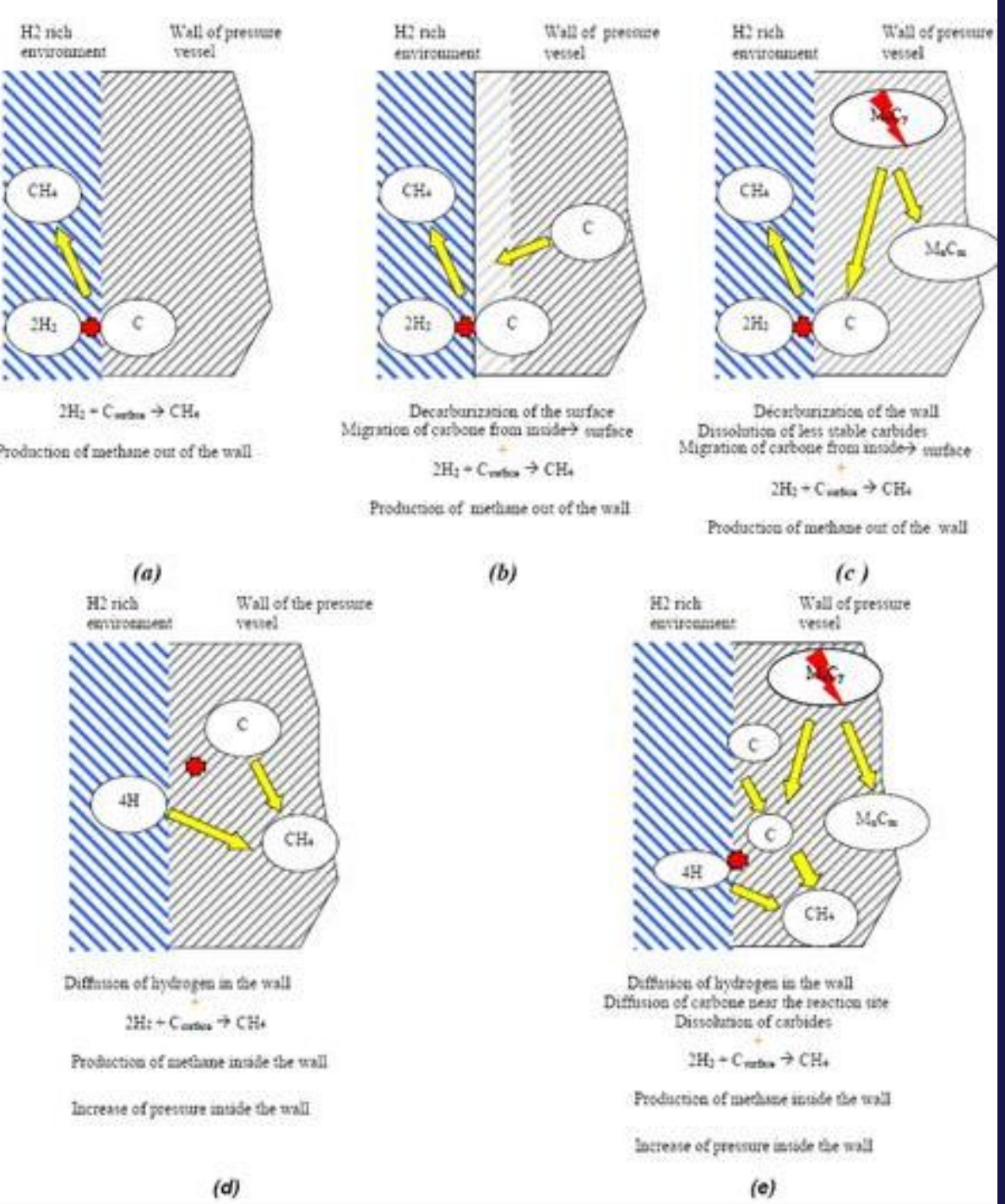
Steel and Hydrogen Attack

Material: Steel

- Used in hydrogen service
- Subject to hydrogen attack

Reference

- Publication: API 941
- Title: Steel for Hydrogen Service at Elevated Temperatures and Pressure in Petroleum Refineries and Petrochemical Plants
- Publisher: American Petroleum Institute
- Location: Washington DC
- Date: April 1990



Steel and Hydrogen Attack

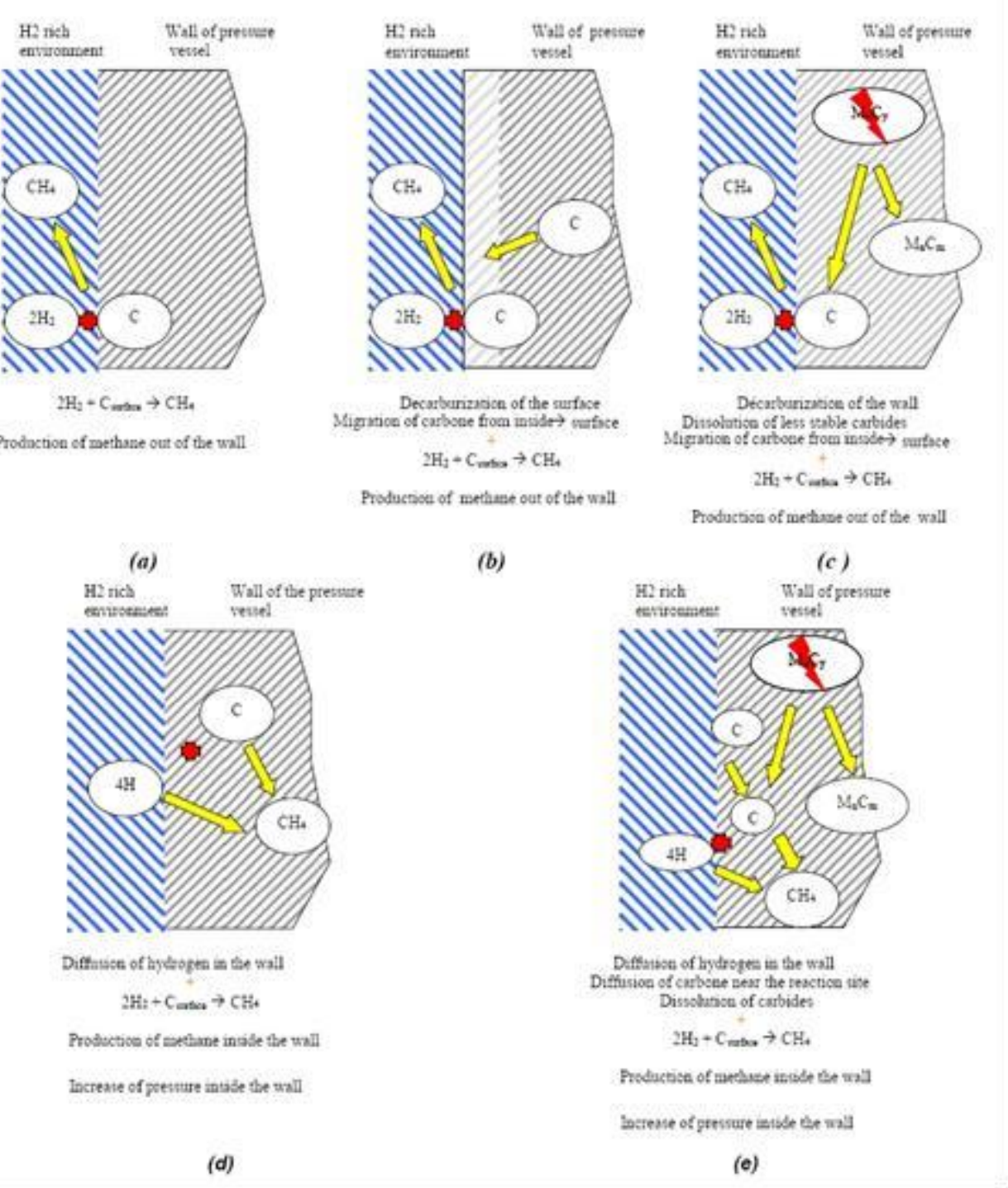
Material: Steel

- Used in hydrogen service
- Subject to hydrogen attack

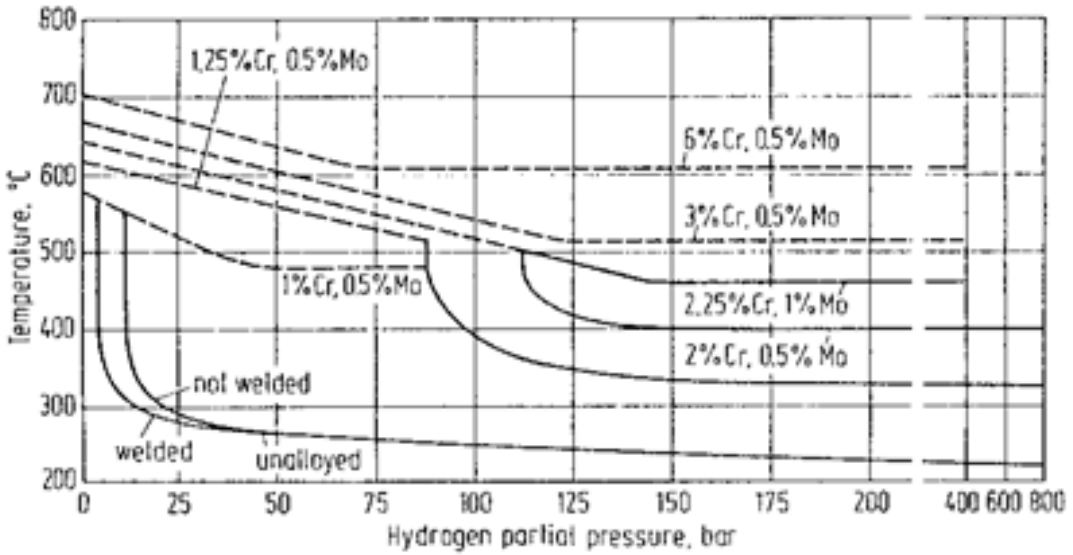
Reference

- Publication: API 941
- Title: Steel for Hydrogen Service at Elevated Temperatures and Pressure in Petroleum Refineries and Petrochemical Plants
- Publisher: American Petroleum Institute
- Location: Washington DC
- Date: April 1990

S.Pillot, P.Bourges, G.Masson,L.Coudreuse, P.Toussaint: Effect of hydrogen on mechanical behaviour for 2 1/4Cr1Mo steel grades (standard and vanadium addend), NACE CORROSION 2008, Paper No. 08559.

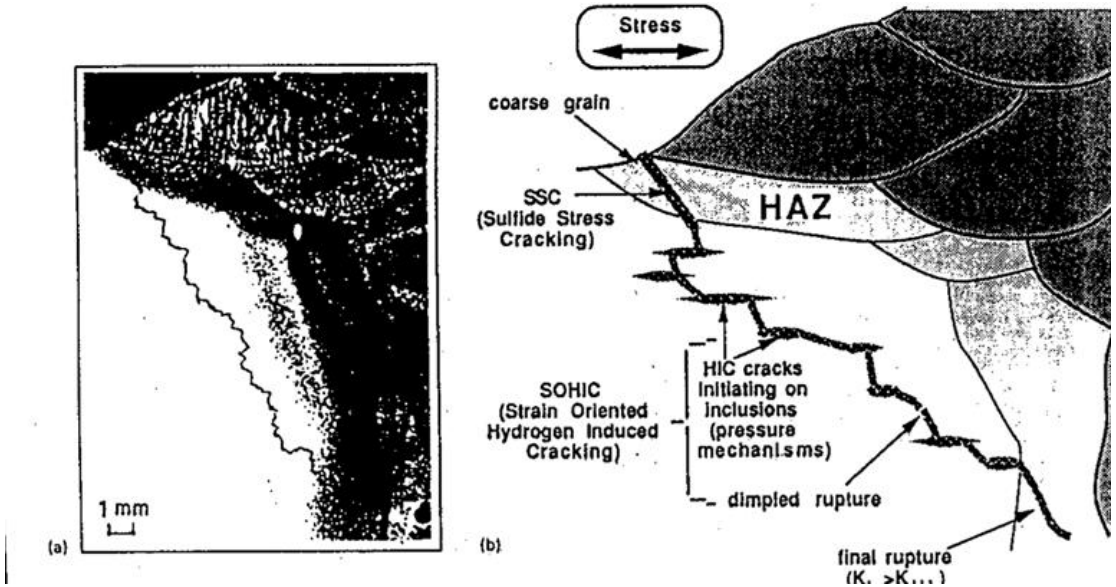


Neslson diagram



„Steel for Hydrogen service at Elevated Temperatures and Presure in Petroleum Refineries and Petrochemical Plants“, American Petroleum Institute, Publ. 941, Washington DC, April 1990.

Steel and Welds



Elastomers and rubbers

Non-metallic materials

- Rapid gas decompression (RGD)
- Permeation rate

Flat gasket

- For the same material is the leakage for hydrogen 2,5 – 10 times higher then by nitrogen

Greases

- For some greases a change in viscosity can accrue

Lutz S, Strauß A. Entwicklung von Prüfgrundlagen für Wasserstoffanwendungen von Elastomeren, Kunststoffen, Schmier- und Dichtmitteln in der Gasinfrastruktur. DVGW-Workshop Sicherheit und Dichtheitsanforderungen unter Wasserstoffanwendung; 2024-06-11; Bonn, Germany

Explosion Risk

Hydrogen Classification

- Hydrogen is in gas group IIC

Paint Thickness Requirements

- Maximum paint thickness is 0.2 mm
- Comparison with A or B where thickness is 2 mm

Seal Requirements

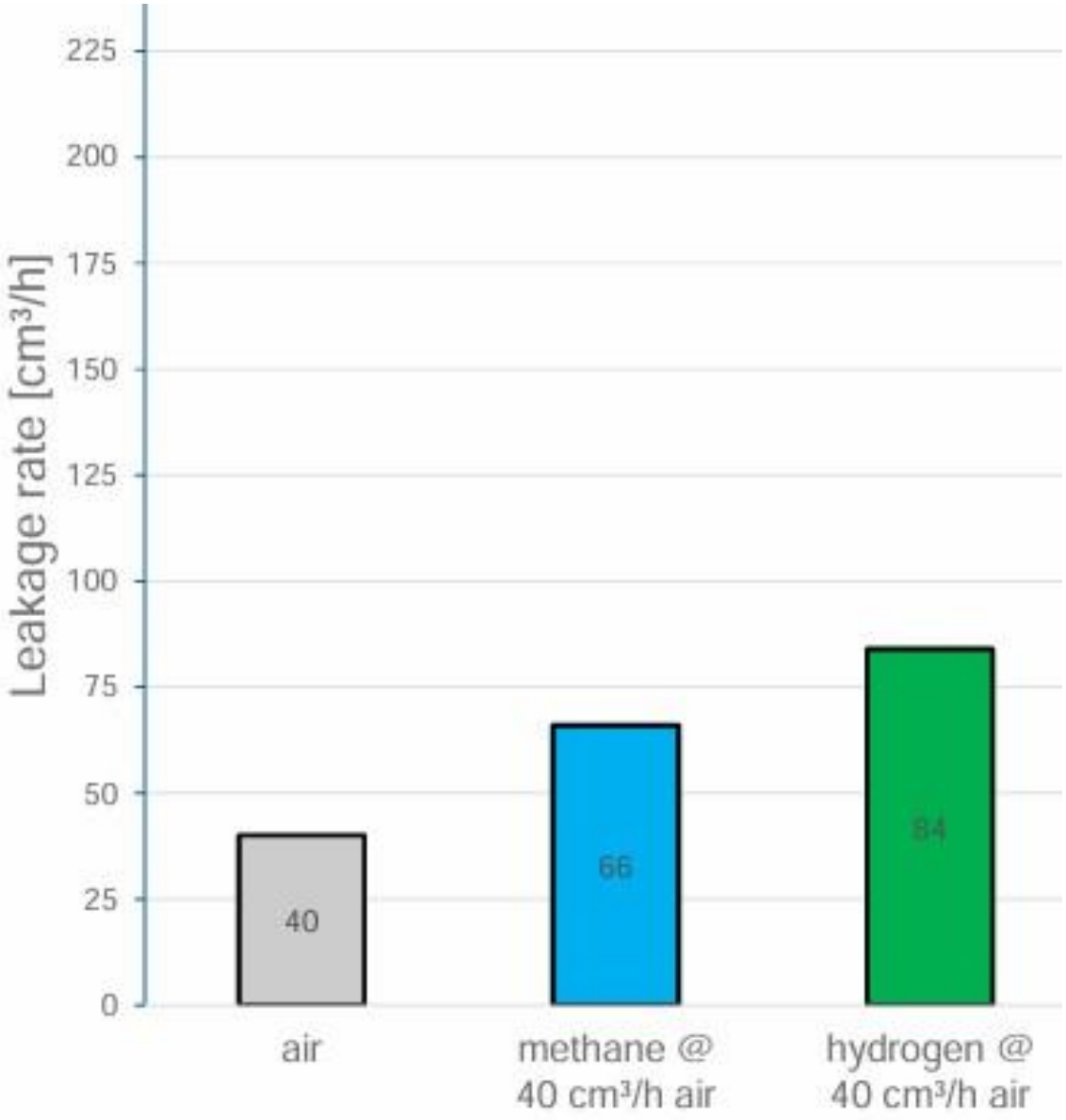
- One additional independent seal needed

Product Color

- Determination of product color complient to ATEX

Ventilation Requirements

- Assessment of ventilation necessity



Leakage and Leakage Detection

Hydrogen vs Methane

- Hydrogen has a 48% higher flow rate
- Hydrogen's lowest explosion limit is 28% lower

Propane vs Methane

- Propane's lowest explosion limit is 72% lower

Butane vs Methane

- Butane's lowest explosion limit is 80% lower

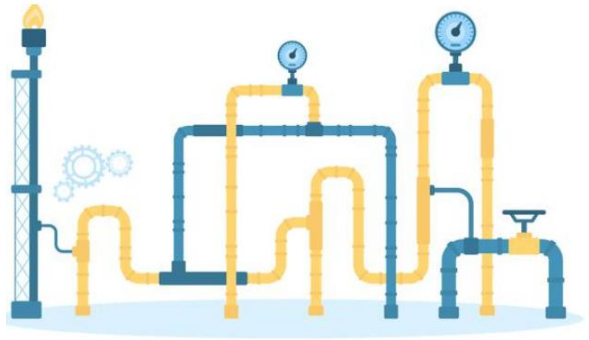
Dalsass K. Guidance on hydrogen specific risk assessments in relation to NG and LPG. DVGW-Workshop Sicherheit und Dichtheitsanforderungen unter Wasserstoffanwendung; 2024-06-11; Bonn, Germany

Detection Methods for Hydrogen Leaks

- Leakage and Detection Techniques
  - Importance of detecting hydrogen leaks
  - Various methods available for detection
- Analyzers
  - Devices used to analyze hydrogen presence
- Optical Methods
  - Techniques using light to detect leaks
- Laser Methods
  - Advanced methods using lasers for precise detection

Comparison of Energy Density with Methane

	Methane	Hydrogen
Density [g/L]	0.657	0.0899
Molar mass [g/mole]	16.043	2.0157
Heating value [MJ/kg]	50.0	119.5
Heating value [MJ/m3]	33.8	10.7



Patrik Sniehotta | Head of R&D

Tel. +420 608 046 078 | patrik.sniehotta@vexve.com

ARMATURY Group a. s. | Nádražní 129 | 747 22 Dolní Benešov | CZECHIA

www.vexve.com