

H₂ compatibility of materials

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Problematics

Two main issues :

⇒ H₂ embrittlement for steel liners (for type III tanks, type IV boss, components)

⇒ H₂ permeation through plastic liners (for type IV tanks)

H₂ embrittlement

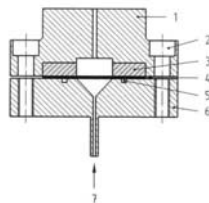
Premature crack of the steel due to H atom dissolution and trap in the metal
⇒ Tank burst or leakage

Influencing parameters

- Hydrogen purity (H₂O, O₂)
- Pressure
- Temperature
- Stresses and strains
- Time of exposure

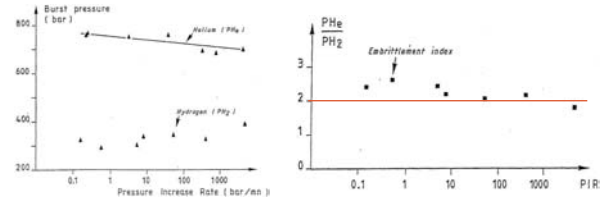
- Microstructure
- Chemical composition
- Heat treatment / mechanical properties
- Welding
- Cold working
- Inclusion

Example of a characterization method



1: Upper flange, 2: Bolt Hole, 3: High-strength steel ring, 4: Disk, 5: O-ring, 6: Lower flange, 7: Gas inlet

Disk testing method – Rupture cell for embedded disk-specimen

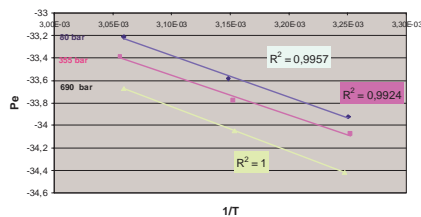


Burst pressure at different pressurization rates for He and H₂. Compatibility to H₂ if index i (Pr(He)/Pr(mixture)) higher than 2

- Chemical composition
- Heat treatment and mechanical properties
- Welding
- Cold working
- Inclusion

Influencing parameters

- Pressure and Temperature



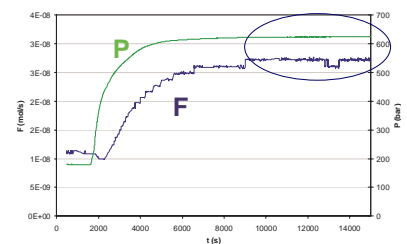
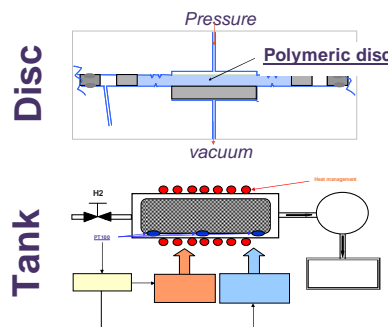
Usual materials used for type IV tanks

- Polyethylene & Polyamid

H₂ permeation

Gas dissolution and diffusion in the polymeric matrix
⇒ Uncontrolled H₂ release

Characterization method



$$\text{Stationary state : } Pe = \frac{F \times e}{A \times P_1}$$

Objective : a permeation rate < 1cm³/L/h

Conclusions

⇒ Characterization on samples and / or whole tanks are necessary before using materials in hydrogen high pressure environment

⇒ Specifications and tests procedures are described in different reference documents (ISO, EIHP,...)