

Overcoming Challenges in Hydrogen System Design

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FITOK

Who are FITOK and NVFCL?

- **FITOK**, a \$0.6bn fluid system solutions provider with over 25 years experience with a network of global sales and service centres
- **Northern Valve & Fitting Company Limited (NVFCL)**, based in the Northwest, are the distributor and service centre for the FITOK across the UK
 - Active member of associations and trade bodies – HIL, Hydrogen Scotland, BCGA, UK HEA, IGEM and Northwest Hydrogen Alliance
 - Collaborated with a major gas cylinder manufacturer to deliver high-profile hydrogen storage systems and an OEM supplier of pioneering hydrogen power units that deliver green off-grid power
 - Active participation in current projects such as HyNet, Teesside Hydrogen Hub, HAR1 awards and HAR2 bids



The Unique Nature Of H2

- H2 is among the smallest molecules in nature, which makes containment challenging
- Critical considerations for leak-tight fitting connections
 - Safety
 - Gas leaks are a safety risk
 - Human interaction during the refueling process
 - Efficiency
 - Effective utilisation of all the hydrogen
 - Eliminate waste due to leakage
- Hydrogen embrittlement
 - H2 molecules at high pressure can diffuse into stainless steel and produce cracks
 - 316/316L materials of construction are critical to reduce the effects of HE

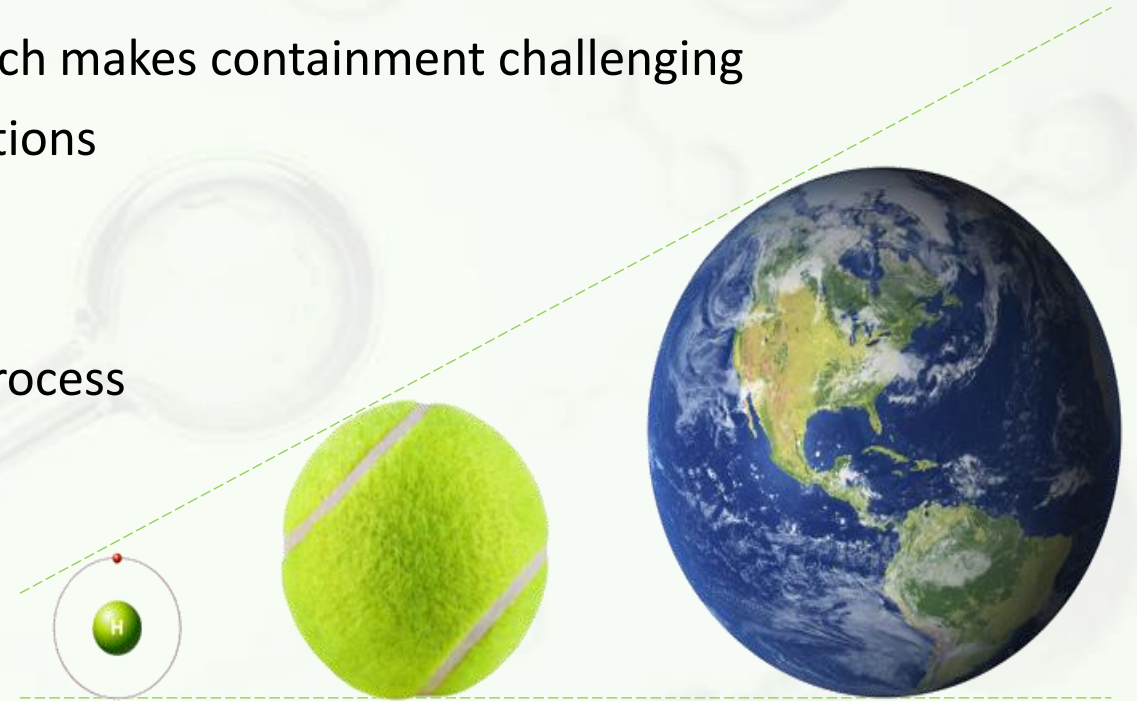
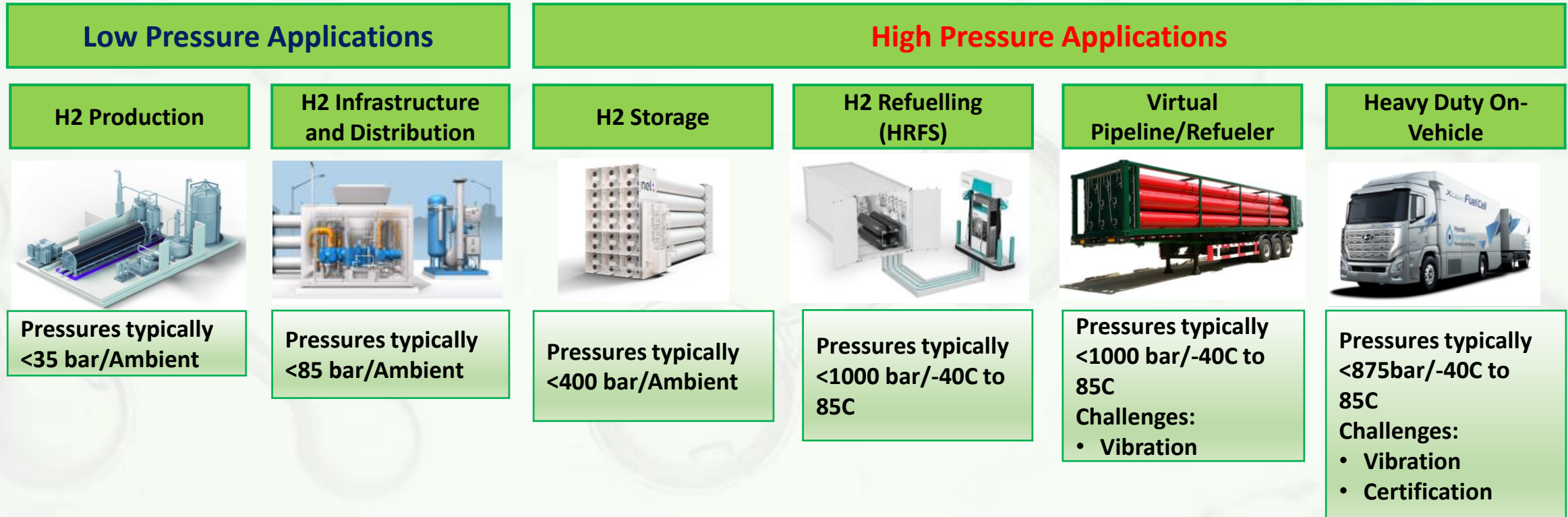


Image Reference: Steven Schimmrich Blog 31/12/2011

Current Jointing Considerations and their Challenges

- A wide range of application pressures up to 1000barg
- An understanding of which existing jointing technologies are not suitable for hydrogen
- Temperature range -40 to +120 C
- Hydrogen applications involving vibration
- Material choices – metals and non-metals
- A need for disassembly/reassembly for maintenance
- How is the hydrogen system to be purged and tested?
- Legacy oil and gas specifications being adopted for hydrogen duty
- Knowing when advanced sealing solutions are needed

Hydrogen Systems Application Focus



Increasing importance in design choices and the correct specifications for fluid system components

Leak Tight Integrity = Quality and Safety

Hydrogen fluid systems components can leak for a variety of reasons:

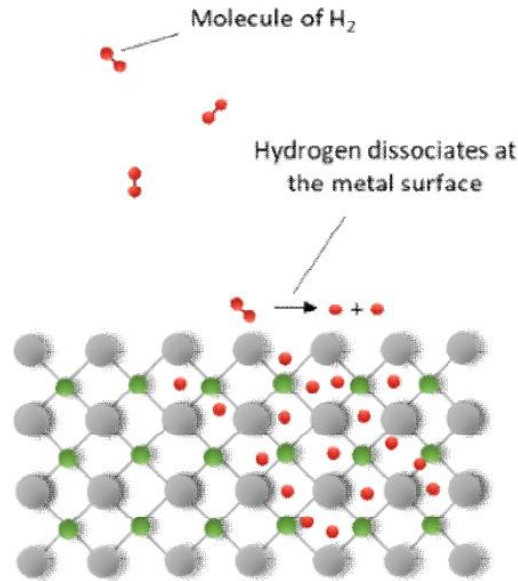
- Poor seal quality
- Poor material selection
- Permeation
- Pressure and temperature changes
- Poor system design and component selection
- Poor installation practices

However, competent system design can mitigate the effects of leakage



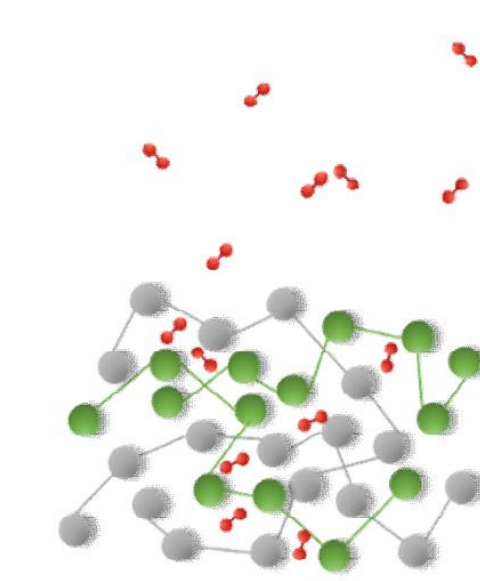
Permeation vs Leakage

PERMEATION



Hydrogen is adsorbed at the metal surface and absorbed in the bulk material where it diffuses as a proton.

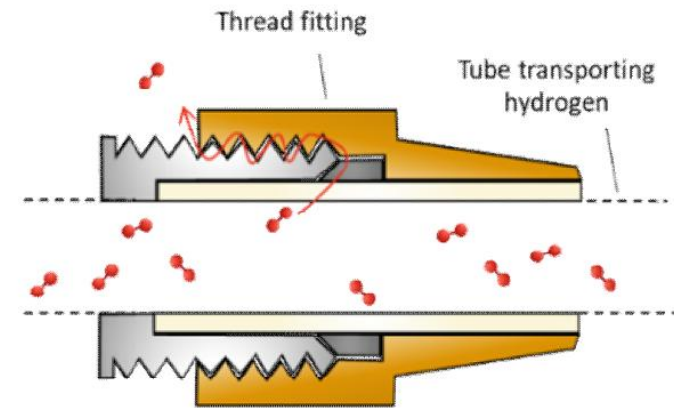
a)



Dihydrogen penetrates at in the plastic material without dissociation

b)

LEAKAGE



c)

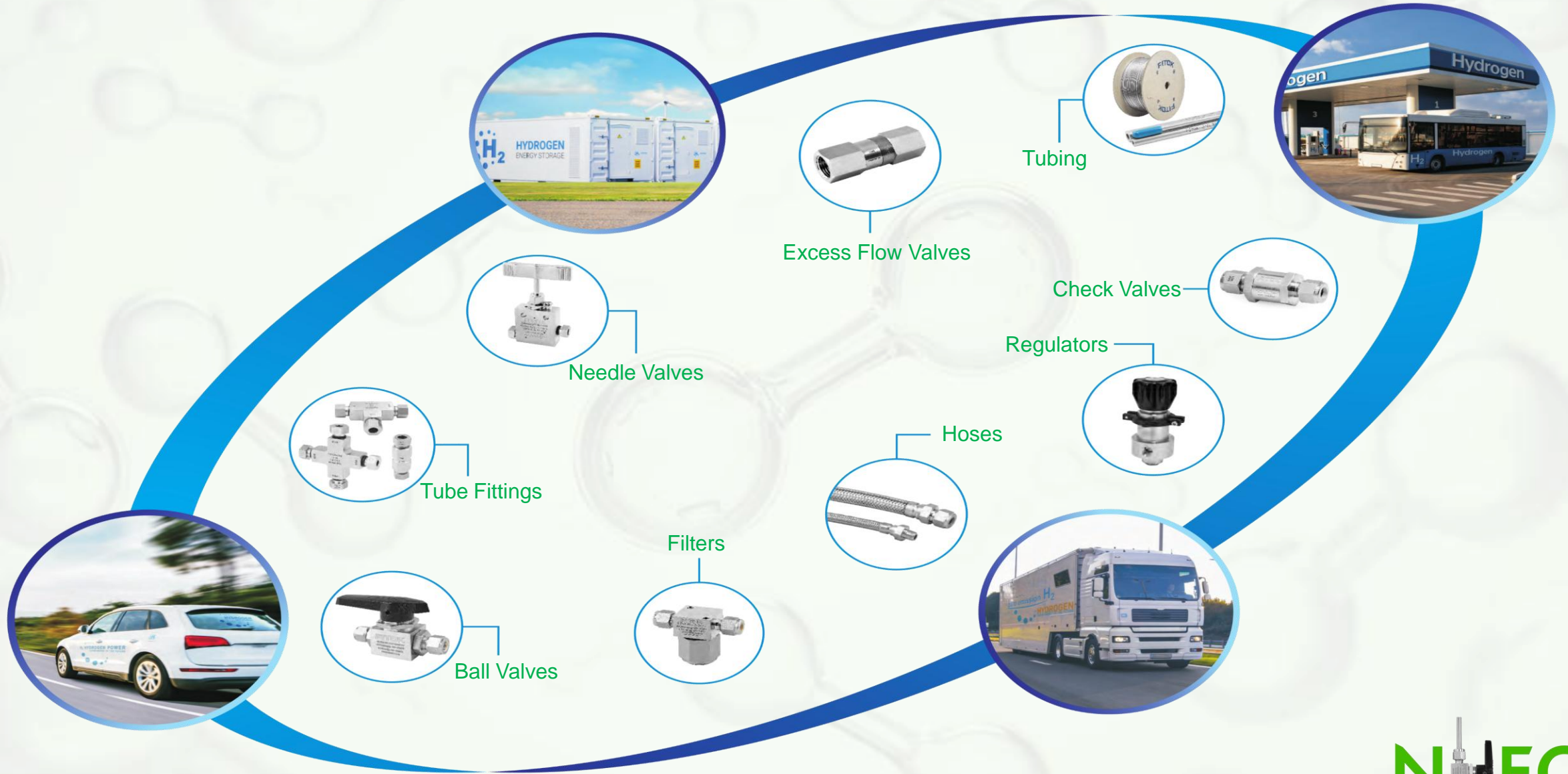
Figure 21 : Schematic representation of permeation in a) a metallic and b) a polymer material and c) leakage through a fitting in hydrogen gas environment.

316/316L Austenitic Stainless Steel

- 316/316L stainless steel alloys:
 - Nickel (stabilizes crystal structure of steel)
 - Chromium (corrosion-resistance)
 - Molybdenum (corrosion-resistance)
- Combatting H2 embrittlement and corrosion
 - ASTM requirements for 316 stainless
 - >10% Ni
 - >16% Cr
- Advantages to increased Cr and Ni
 - FITOK >12% Ni
 - FITOK >17% Chromium

Element	ASTM 316/316L Stainless Steel (%)	FITOK 316/316L Stainless Steel (%)	Industry trend (%)
Chromium	16-18	17-18	16-16.5
Nickel	10-14	12-14	10-10.5

Product Offering for Hydrogen

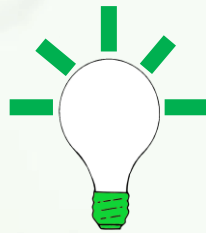


Education and Training

- Education is the key to dismissing myths about hydrogen
- Adapt skillsets to include hydrogen knowledge
- Raising awareness of hydrogen properties, risks and best practices
- Hydrogen system design courses to increase knowledge for designers and users
- Hydrogen system installation courses to upskill contractors from other industries



Installation & Safety
Training



Competence & Skills
Development



Standardised Training
and Consistency

On-Site Project Support Services: For Increased Safety

- Highly trained network of technical engineers, specialising in hydrogen small bore tubing systems
- Competency and skills development
- Product specification and selection support
- Evaluation and optimisation of existing system designs
- Site support during installation and/or commissioning
- Advice on best practise



Thank you!

FITOK