

# 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 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

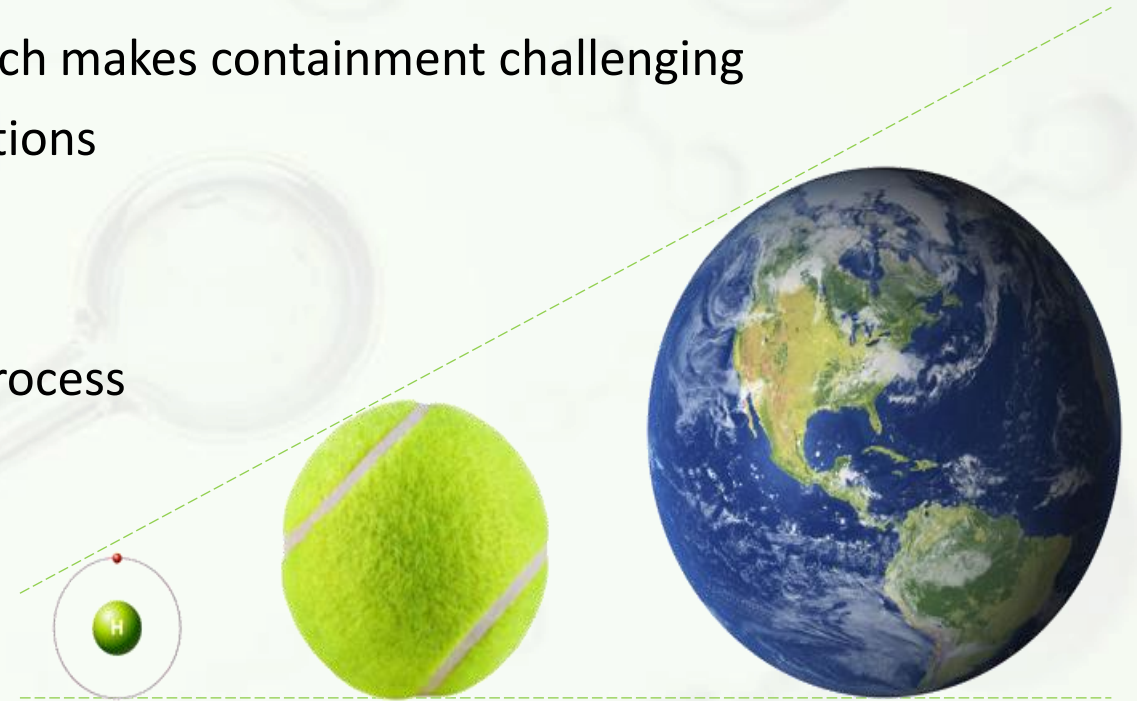


Image Reference: Steven Schimmrich Blog 31/12/2011

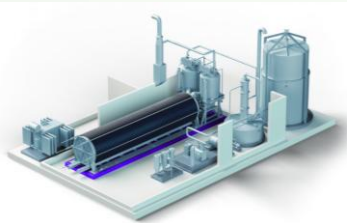
# Current Jointing Considerations and their Challenges

- 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
- System vibration
- Material choices – metals and non-metals
- Flammability
- A need for disassembly/reassembly for maintenance
- Purging and testing of systems
- Knowing when advanced sealing solutions are needed

# Hydrogen Systems Application Focus

## Low Pressure Applications

### H2 Production



Pressures typically  
<35 bar/Ambient

### H2 Infrastructure and Distribution



Pressures typically  
<85 bar/Ambient

### H2 Storage



Pressures typically  
<400 bar/Ambient

## High Pressure Applications

### H2 Refuelling (HRFS)



Pressures typically  
<1000 bar/-40C to  
85C

### Virtual Pipeline/Refueler



Pressures typically  
<1000 bar/-40C to  
85C

Challenges:  
• Vibration

### Heavy Duty On- Vehicle



Pressures typically  
<875bar/-40C to  
85C

Challenges:  
• Vibration  
• Certification

Increasing importance in design choices and the correct specifications for fittings and tubing

# Leak Tight Integrity = Quality and Safety

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

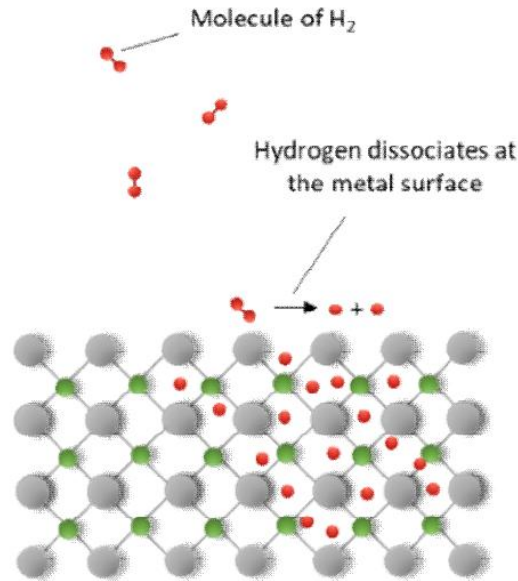
- Poor seal quality
- Poor material selection
- Permeation
- Pressure and temperature changes
- Poor system design and component selection

However, competent system design can mitigate the effects of leakage



# Permeation vs Leakage

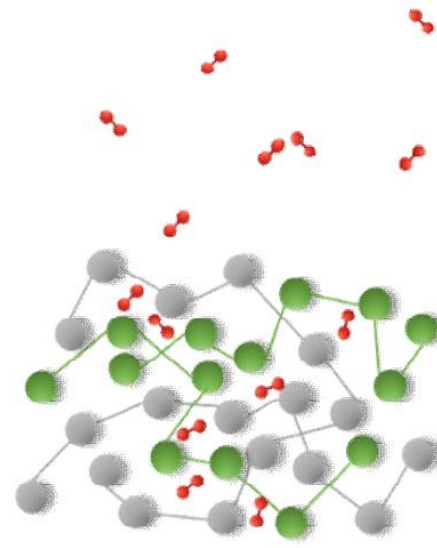
## PERMEATION



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

a)

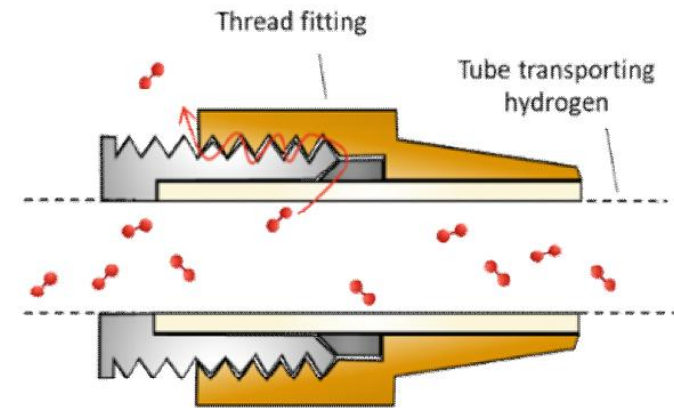
## PERMEATION



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



Tubing



Excess Flow Valves



Check Valves



Regulators



Hoses



Needle Valves



Tube Fittings



Filters



Ball Valves

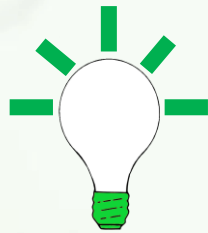


# Education and Training

- Education is the key to dismissing myths about hydrogen
- Adapt skillsets to include hydrogen knowledge
- Awareness courses for hydrogen properties, risks and best practices
- Design awareness courses, purging, and safe selection of components
- 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**