

# Testing Challenges for H2

# Welspun World - Diversified Business Interests



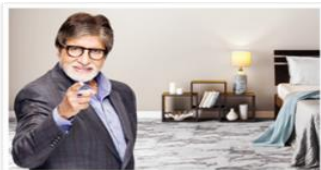
HOME TEXTILES & RETAIL



LINE PIPES



INFRASTRUCTURE



FLOORINGS



SS Seamless PIPES & TUBES



OIL & GAS



ADVANCED TEXTILE



BUILDING MATERIAL



HEALTH & HYGIENE



WAREHOUSING & LOGISTICS

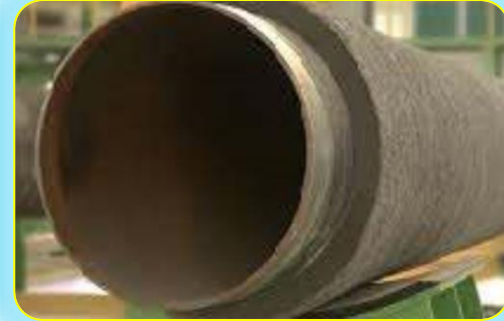
# Products



**LSAW Line  
Pipes**



**Pipe Coating**



**Concrete  
Coating**



**HSAW Line  
Pipes**



**HFW Line Pipes**



**Induction  
Bends**



# Green Hydrogen

# Welspun's Strategy - Green Steel & Green Pipe



## **Green Hydrogen –*Customers***



## **Green Steel –*Steel Suppliers***



## **Green Pipe –*Welspun***



# Objective



- ❑ Welspun is currently working with some of the Approved steel suppliers and existing International Clients :
  - a. Qualification Program for Hydrogen Pipeline – (Pure H<sub>2</sub> & Blended H<sub>2</sub> with NG)
  - b. Green Steel development
  
- ❑ We would like to have similar joint developmental qualification program for Hydrogen Pipeline with potential Customers.

# Important Codes/ Standards



- International:
  - ASME B31.12: 2019  
Design standard for pipelines, two design approaches
  - EIGA DOC 121/14  
Design recommendations for pipelines
  - EN standard (Europe)  
Currently revising the existing standards EN1594 to include H2 transportation
  - AS standard (Australia)  
Currently revising the existing standard AS 2885 to include H2 transportation
- Upcoming Guidelines / Recommended Practices
  - DNV - Guideline on Design, Construction and Operation of Hydrogen pipelines is expected by 2024/2025





# Classification of Hydrogen

Green	Blue	Grey	Brown	Black
<ul style="list-style-type: none"><li>Hydrogen by electrolysis of water using renewable energy</li><li>No CO2 Emitted</li></ul>	<ul style="list-style-type: none"><li>Split Natural gas in to Hydrogen and CO2</li><li>CO2 Store or reused</li></ul>	<ul style="list-style-type: none"><li>Split Natural gas in to Hydrogen and CO2</li><li>CO2 emitted in to atmosphere</li></ul>	<ul style="list-style-type: none"><li>Made from brown coal</li></ul>	<ul style="list-style-type: none"><li>Made from black coal</li></ul>

Other types of H<sub>2</sub>: White (naturally occurring); Turquoise (solid carbon as a by-product); Pink (from nuclear energy); Yellow (using a mix of whatever is available) – TOTAL 9 TYPES

# Slow Strain Rate Test

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- Tensile test using round specimens as per ASTM G142/ ASTM G129 at low strain rate (may be  $10^{-6}$  s $^{-1}$ )
- Challenges:
- The amount of time specimens are required to be exposed to H<sub>2</sub> environment prior to testing is not defined
- Acceptance criteria for different API grades particularly X60M PSL2 and above in terms of YS, UTS etc. needs to be specified
- Testing using round bar specimens during production is time consuming. Conventionally flattened type specimens are being used.



- KIH testing to be carried out as per Option B of ASME B31:12, ASME BPVC Sec. VIII, Division 3, article KD- 10 & ASTM E1681.
- Testing to be carried out on 3 heats. From each heat, 3 specimens each from BM, WM & HAZ
- Test duration - 1000 hours
- Test pressure - 103 bar for grades X60, X65
- Challenges:
- The test is specified for material qualification and not specifying requirements with respect to regular production
- Test duration is very high and regular production cannot be started from before completion of the above tests, if to be carried out during MPQT
- Limitation of pressures for higher grades
- Require a single standard for carrying out the tests, as it is referring to multiple standards for line pipes

# Fracture toughness in hydrogen environment

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- As per ASTM E 1820 “Standard Test Method for Measurement of Fracture Toughness”;
- K-rate:  $0.005 \text{ MPa}\cdot\sqrt{\text{m/s}}$ ;
- Total 3 (three) specimens;
- C(T) specimens or SEN(T)

## Challenges:

- ASTM E1820 is not applicable for H<sub>2</sub>
- If test is to be carried out in H<sub>2</sub> environment, whether specimens are required to be exposed in H<sub>2</sub> environment prior to testing, during testing is not clear
- Test duration etc. is not clear.

# Fatigue Crack Growth Rate Tests

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- Testing : As per ASTM E647
- Specimen type: C(T)
- Test frequency:  $\leq 0.1$  Hz
- Load ratio  $R = 0.5$
- No. of specimens : 3
- Deliverables: Paris curve & fracture surface analysis
- Challenges:
  - ASTM E647 is not for testing in H<sub>2</sub> environment. Specific standard for testing in H<sub>2</sub> environment is required.
  - Effect of loading rate and loading time for constant loading scenarios is critical and needs to be defined.



**Thank You!**