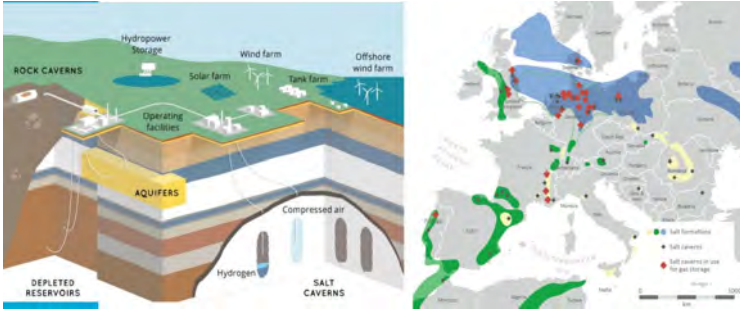


INTRODUCTION

Energy sectors are looking at hydrogen as best option as a zero-carbon emission and environmentally friendly fuel. Hydrogen will play an important role in energy supply in the future. There is insufficient research data about storage facilities for hydrogen and transportation of hydrogen. Since the oil and gas industry wants to replace the gas with hydrogen in storages (salt caverns). Many oil and gas companies are working on hydrogen gas storage projects. Sustainability of carbon Steels in Underground Hydrogen Gas Storage Facilities' is one of those projects on which our team is working.



Schematic view of salt caverns for hydrogen storage and sites in Europe

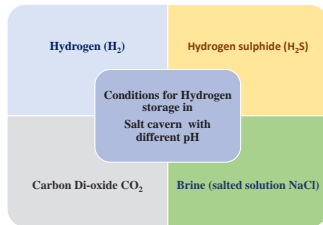
EXPERIMENTAL METHODS

Materials

- Carbon Steels (API 5CT) and Welds

Following experimental methods and Environments are invested.

- Presence of sulphide reducing bacteria and brine with Cl⁻
- H₂+H₂S+CO₂+5% NaCl brine
- pH = 4.0 to 6.5



Constant Load Testing (CLT)



- load at 90% of yield strength.
- RPM – 1cycle/1min
- Wet conditions at high partial pressure of hydrogen
- Dry and wet
- 20 to 80 °C

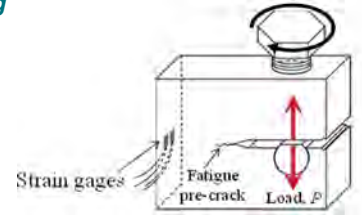
Constant Load specimen



Specimen for measurement of hydrogen uptake

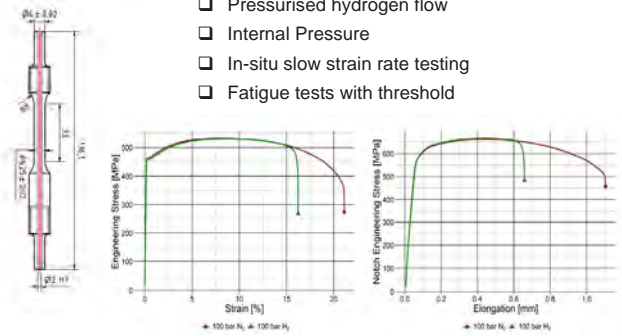
Fracture Mechanics Testing

- Standard -ASME B31.12
- Constant displacement Test
- CT- specimen with bolt
- K_{IH} > 55 MPa m^{1/2}
- Pre- fatigue cyclic crack



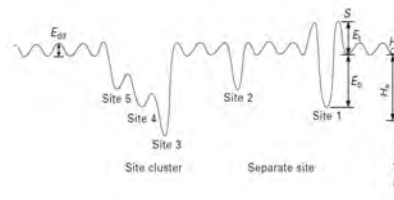
Slow Strain Rate Testing with Hollow Probes

- Pressurised hydrogen flow
- Internal Pressure
- In-situ slow strain rate testing
- Fatigue tests with threshold



Hydrogen Measurement

- Pre-cooling after H-charging by liquid Nitrogen
- Thermal Desorption Spectroscopy (TDS)
- Testing with different temperature
- Desorption energy calculations of Hydrogen traps



- Binding Energy
- Trapping Energy
- De-Trapping Energy
- Trapping Sites

Schematic View of trapping, de-trapping and diffusion energy of hydrogen at different trapping sites

OBJECTIVES

- Cross verification of susceptibility of steel in hydrogen environment by three methods
- susceptibility of welds and heat affected zones in hydrogen environment
- Characterization of steels in hydrogen
- Determine susceptibility of alloys to hydrogen
- Determine the hydrogen content and diffusivity
- Learn limits of applicability of steels

Contact

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