HUG INTERIM SEMINAR – WP3B ACTIVITIES / MATERIALS AND STRUCTURES

JANUARY 22ND 2026

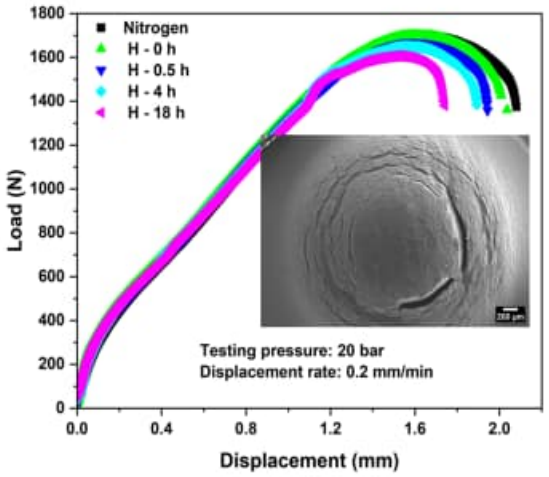
Programme

WP 3b – Activities regarding materials and structures in LRC/LRS type storages

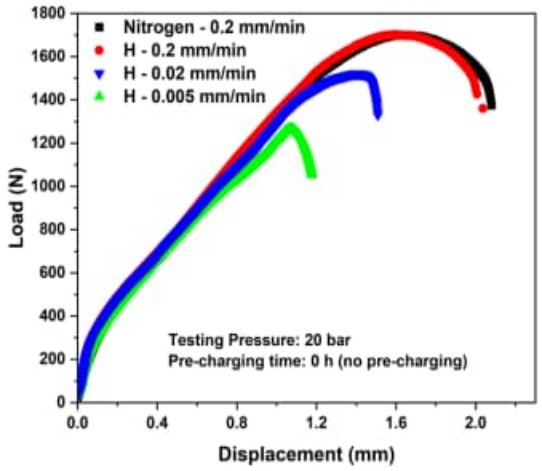
- Patent landscape analysis done => not many of them concerning storage materials or structures
- Preliminary rock engineering model done (by Sweco)
- Preliminary structural options discussed
  - Preliminary calculations / dimensioning for certain type structural solution done (first round)
    - Creep analysis will be done during the spring for defining the preliminary creep profile
  - Constructional challenges and bottle necks identified
    - More detailed structural analyses (several different loading scenarios) needed in HUG2 => strongly linked with rock engineering and rock mechanics
- Detailed research needs for liner materials (metals, concrete, friction layer material) are well identified => preparation of research plan has started for HUG2
  - E.g., for metals: mechanical performance of hydrogen (hydrogen embrittlement, low cycle fatigue, local strains), ground water corrosion (groundwater and concrete chemistry and microbiology)
  - E.g., for concrete: mix design optimization and material characterization, compression and splitting tensile strengths, modulus of elasticity, creep and fatigue tests, shrinkage tests, interactions between H2 leakages and moisture in concrete, transport and migration properties of concrete, adiabatic heat development, modelling of coupled degradation mechanisms (Freeze-thaw, ASR/ISR/DEF, dissolution of calcium compounds), validating material behavior under static, dynamic and cyclic loading, modelling of structural integrity in relation to degradation mechanisms, triaxial concrete strength test
  - E.g., for friction layer material: mechanical properties in interaction of steel liner and concrete, traction separation, resistance for shear and tensile stresses, chemical stability (groundwater and concrete chemistry)
- Report of materials and structures of HUG1 will contain proposals and justifications for further actions needed

Hydrogen embrittlement of X70 pipeline steel in high pressure gaseous hydrogen

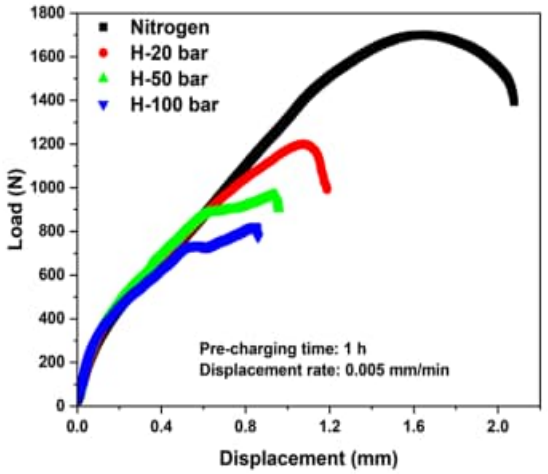
Effect of charging time



Effect of displacement rate

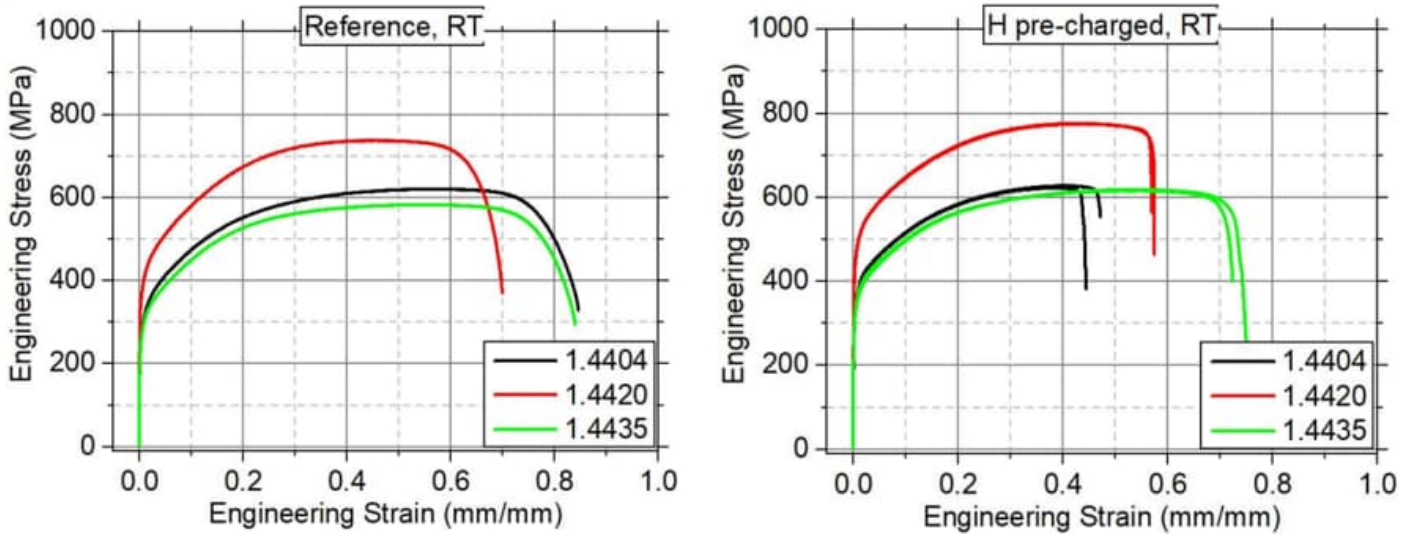


Effect of H2 pressure



Ref: C. Soundararajan et al., Gaseous hydrogen embrittlement behavior of API-X70 pipeline steel investigated using in-situ small punch test. SSTT 2025 – 7th International Small Sample Test Techniques Conference. 16.-18.9.2025.

Effect of internal hydrogen on tensile properties of AISI 316 variants



	C	Si	Mn	P	S	Cr	Ni	Mo	N	Cu
1.4404 (316L)	0.01	0.3	1.0	0.03	0.001	16.8	10.1	2.0	0.1	
1.4420 (316Lplus)	0.02	0.5	1.8	0.03	0.001	20.2	8.7	0.7	0.2	0.5
1.4435 (316LNiMo)	0.01	0.2	1.6	0.03	0.001	17.2	12.7	2.5	0.1	

H pre-charged to saturation (140 wt-ppm H) AND tested in air

- 2 weeks @ 1 380 bar H2, 300 °C

J. Pakarinen et al., Effect of Composition on Tensile Properties of AISI 316 Variants with Internal Hydrogen. ASME 2025 Pressure Vessels & Piping Conference (PVP2025), July 20-24, 2025. Montreal, Canada.