Repurposing Natural Gas Pipelines for 100% Hydrogen Transport

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PROJECT OVERVIEW

HyGrid2 project is the first project in Austria for repurposing an existing natural gas pipeline for 100% hydrogen transport. The project is supported by the Austrian Research Promotion Agency (FFG) as a crucial step towards achieving the goal of carbon neutrality by 2050. Hydrogen transport cost and hydrogen embrittlement (HE) are the most serious challenges of the hydrogen transportation process. Therefore, repurposing the present infrastructure is considered as an extremely cost-effective process. Meanwhile, HE is a serious phenomenon that deteriorates metals in hydrogen environment. Thus, this research aims to evaluate the different grid parts including their welds, in terms of HE susceptibility for safe and efficient operation in the future.

Grid territory of Energienetze Steiermark

GRID INTEGRITY EVALUATION

The pigging process is performed to evaluate the current status of the grid in terms of wall thickness and defects using ultrasonic testing. Moreover, X-ray inspection is also involved in welds inspection to assess the integrity of the present infrastructure and know which flaws and defects, such as cracks, voids, slags, pores and notches, are present.

Pigging tool for pipeline inspections

GRID SAMPLING

Different parts of the grid representing different materials with varied geometries are sampled for residual stress evaluation and to be machined for subsequent destructive mechanical tests. The machined specimens include specimens for Constant Load tests, Hollow Probe tests, Compact Tension tests and Hydrogen Permeation experiments for welds and base metals.

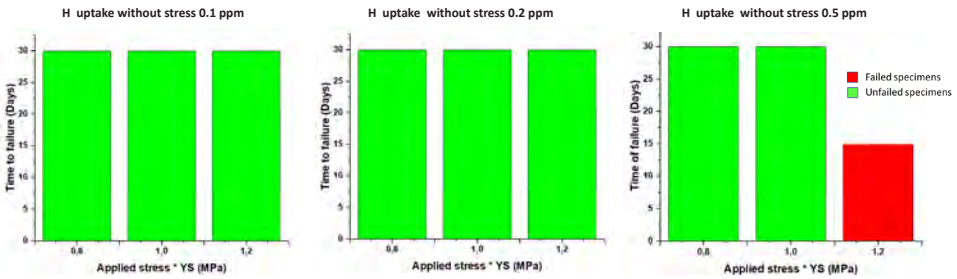
Different samples of the grid

TESTING METHODS

- Constant Load Test (CLT)
- Hydrogen Permeation Test
- Slow Strain Rate Test (SSRT)
- Ripple Load Test (RLT)
- Fracture Mechanics (CT)

PRELIMINARY RESULTS OF CONSTANT LOAD TEST

Some of the constant load tests under varied loading stresses were performed in different hydrogen environments to assess the hydrogen uptake behaviour + hydrogen embrittlement susceptibility of X52 pipe grade. The X52 material has mechanical properties of 353 MPa YS, 492 UTS MPa and 25% elongation.



120 bar H_2 | 120 bar H2 + 1 bar H_2S | 120 bar H_2 + 1 bar H_2S + 5% NaCl

CONCLUSIONS

- The study will contribute to a swift implementation of a cost-effective and efficient hydrogen distribution system
- According to the International Energy Agency (IEA), repurposing an existing pipeline saves 50-80% of the cost compared to setting up a new one.
- The different specimens will be subjected to tests in different hydrogen environments to determine the HE susceptibility under varied conditions
- The research outputs should answer the open questions by 2025 to create a manual for operating the repurposed grid safely and efficiently.
- Dry hydrogen doesn't yield to measurable embrittlement of X52 material up to 1.2 * YS
- Dry hydrogen + hydrogen sulfide don't yield to measurable embrittlement of X52 base material up to 1.2 * YS
- Hydrogen + hydrogen sulfide + 5 % NaCl solution yield to hydrogen embrittlement of X52 base material at 1.2 * YS

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