THE EFFECT OF HYDROGEN GAS ON TENSILE PROPERTIES OF A HIGH STRENGTH CARBON STEEL

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ABSTRACT
Nowadays, in the drive towards a greener society, hydrogen technologies are arising as key alternatives to traditional carbon-based energy sources. Building a hydrogen economy requires improvements in all its facets, including production, storage, and transport.

One of the most well-known impediments to this transition is the detrimental effect of hydrogen on material properties, particularly their mechanical strength and ductility, commonly referred to as hydrogen embrittlement, which can lead to premature failure. Thus, research on the mechanical behaviour of materials in hydrogen environments is crucial to determine their suitability for such applications. Throughout their service life, high strength carbon steels commonly used in pipelines and storage vessels, face regularly cyclic pressure fluctuations, that lead to fatigue and different stresses including hydrogen-induced stress. It is essential to correlate their mechanical properties with their microstructure and composition to understand the sensitivity to hydrogen embrittlement, as well as the solubility, diffusivity and hydrogen trapping in different types of high strength carbon steels.

In this work the effect of hydrogen gas on the tensile properties of a high strength carbon steel has been studied. The steel had ultimate tensile strength of 530 MPa with ferritic/pearlitic microstructures. The hollow specimen method (HSM) was used to perform slow strain rate tests (SSRT) [1] to evaluate the behaviour of the steel in a pressurised environment of inert gas (Ar) and hydrogen (H_2) at room temperature and 200 bar pressure. To reveal whether hydrogen gas/steel interaction and hydrogen absorption occurred the SSRT specimens after testing were analyzed using thermal desorption spectroscopy with mass spectrometry (TDMS). Fractographic analysis (LOM, SEM) was carried out to inspect whether the steels experienced hydrogen embrittlement.

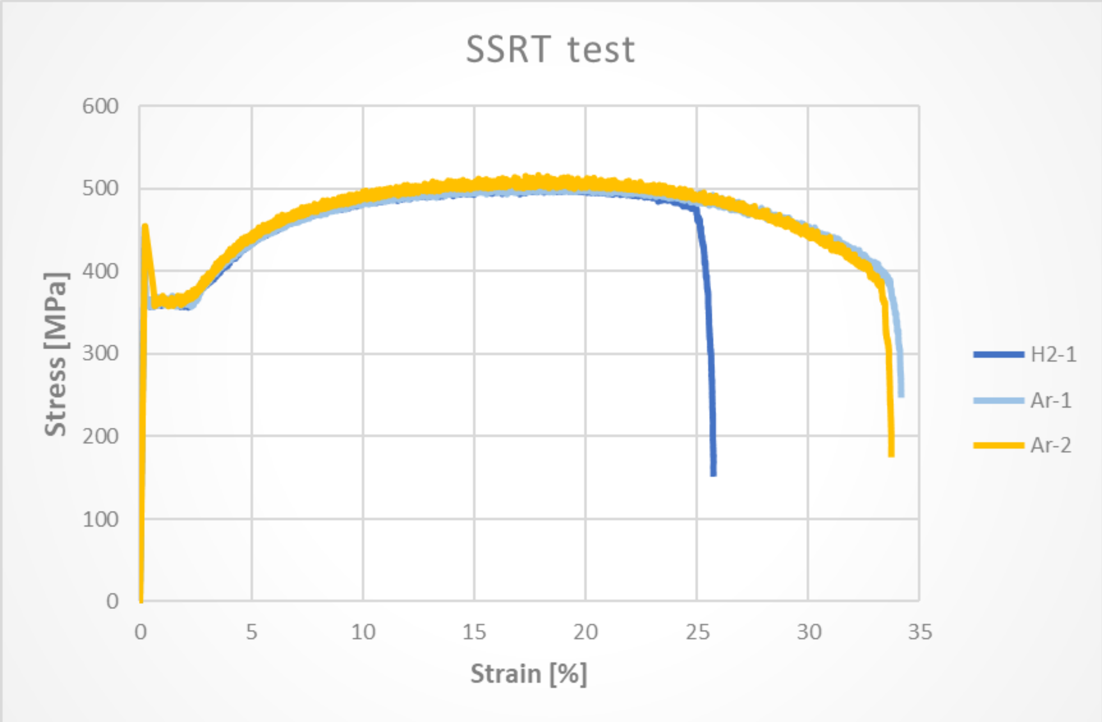

Fig.1 Stress-Strain curve for SSRT test, specimens in Ar and H_2*environment for strain rate of* $10^{-6}s^{-1}$.

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