EUROPIPE Pipes - Ready for 100 Percent Hydrogen

Recent hydrogen suitability tests conducted by EUROPIPE and the National Institute for Standardization and Technology (NIST) in Boulder, Colorado, have confirmed that EUROPIPE's L485 (X70) pipes **are capable to be used for future hydrogen pipelines** designed according to ASME B31.12. The tests showed that **the steel even exceeds the properties** assumed in the standard in a 100 bars pure hydrogen atmosphere.

The investigation is part of EUROPIPE's hydrogen research program, where different grade L485 steels and sour service L450 are tested in pure hydrogen. The investigations focus on the parameters from the pre-material as microstructure and steel chemistry, which might play an improvement role on the hydrogen performance of the pipes.

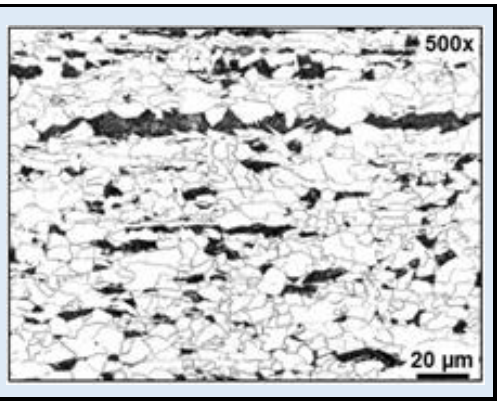
The testing protocol followed ASTM E1820 for the quasi-static testing and ASTM E647 for the cyclic testing. The investigated material originates from rolling and alloying concepts for deliveries of onshore pipelines based on TMCP plate. The results from this testing covers the hydrogen performance of the lower grades. Quasi-static and cyclic fracture mechanic tests were carried out at 100 bars pressure of pure hydrogen with very good results.

In comparison with the ASTM E1681, the quasi-static ASTM E1820 testing method exhibits more significant results and the procedure is representing more the tough material behaviour also in hydrogen atmospheres.

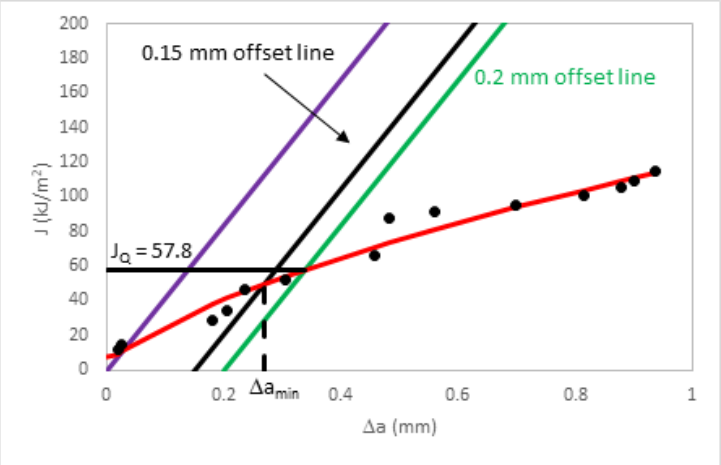
Though deviating from ASME BPVC, the selected test method provides a quantitative material property, which gives an impression of the big safety margin of the EUROPIPE material in hydrogen operation exceeding significantly the code's design values.

The ASTM E1681, which is fixed in the code, violates basic fracture mechanical rules for the material investigated and gives only a pass/not pass test response without any indication about safety margins.

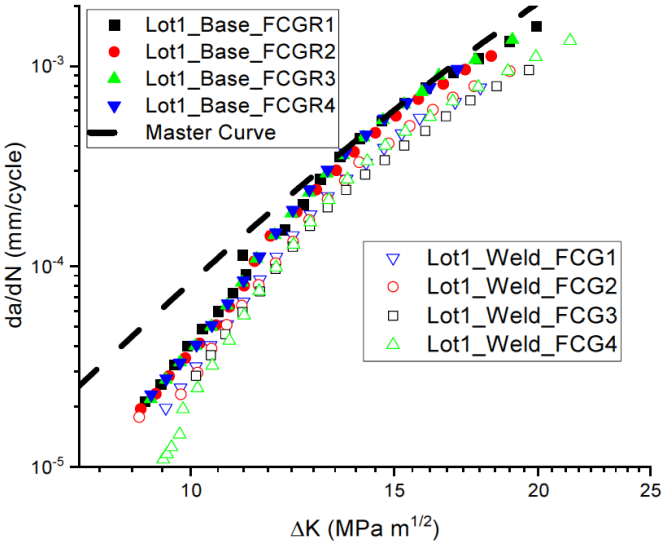
C	Mn	Si	P	S
≤0.12	1.6-1.8	≤0.45	≤0.020	≤0.002
Ni	Cu	Cr	CE	PCM
-	-	-	≤0.42	≤0.22
$R_{t0.5}$	R_m	Y/T	A_f	
485-605	570-760	≤0.85	≥18%	



The quasi-static testing in the heat affected zone of the seam weld, which is known to be the pipe region with the lowest toughness, exhibits a $K_{J,Ic}$ value of 114.5 MPa√m, which is more than double of the design value (55MPa√m) from the ASME code.



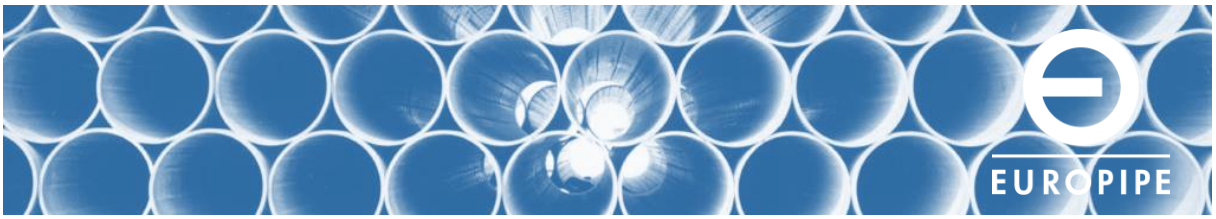
J_Q = 57.8kJ/m² => KJ,Ic = 114.5 MPa√m



The cyclic testing at K_{min}/K_{max} ratio of 0.5 resulted in a da/dN-ΔK-curve, which is below the master curve of ASME B31.12 providing a lower crack propagation ratio than assumed in the ASME code. The design values are very conservative assumptions for the usual operation conditions with respect to the level of pressure cycles and the stress intensity.

With these material results, EUROPIPE contributes to more clarity for the technical challenge in a safe hydrogen transport via pipelines.

Dr. Christoph Kalwa, October 2021



For further information

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About EUROPIPE

EUROPIPE GmbH based in Mülheim an der Ruhr, Germany, is the world market leader in welded large-diameter steel pipe production. The EUROPIPE Group with locations in Germany and the USA employs a workforce of some 1,000 worldwide. Its production capacity amounts to over 1 million tons or 3,000 kilometers of large-diameter pipe per year. EUROPIPE is owned in equal shares by AG der Dillinger Hüttenwerke and Salzgitter Mannesmann GmbH.

www.europipe.com

About National Institute for Standardization and Technology (NIST)

The National Institute of Standards and Technology (NIST) was founded in 1901 and is now part of the U.S. Department of Commerce. NIST is one of the nation's oldest physical science laboratories.

From the smart electric power grid and electronic health records to atomic clocks, advanced nanomaterials, and computer chips, innumerable products and services, rely in some way on technology, measurement, and standards provided by the National Institute of Standards and Technology.

Today, NIST measurements support the smallest of technologies to the largest and most complex of human-made creations—from nanoscale devices so tiny that tens of thousands can fit on the end of a single human hair up to earthquake-resistant skyscrapers and global communication networks.

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