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Certification of hydrogen material compatibility based on TÜV SÜD test standard P-003

Objective of TÜV SÜD test standard P-003:

Hydrogen will play an important role in tomorrow's energy system to reduce carbon emissions and reach decarbonization goals. Therefore, components for gas systems need to be suited for the usage with hydrogen to be future proof ("H_2-Readiness"). But as hydrogen implies several complex damage mechanisms, the proper material selection to ensure a safe and reliable operation is a demanding task.

The resistance of materials to compressed hydrogen depends primarily on the material properties. As an example, for metallic materials the microstructure and grain size which in turn relies on e.g. the chemical composition and the manufacturing method, will have an influence in hydrogen use. In addition, the resistance is also a function of system variables such as the hydrogen partial pressure, the hydrogen purity or external mechanical stresses.

At the moment, the current European regulations only provide vague statements like: "A material in hydrogen application has to be resistant against hydrogen". The specifications and recommendations in the current international codes on the resistance of materials to hydrogen under pressure are very similar but differ from one another in some details.

The TÜV SÜD test standard P-003 "Material compatibility against compressed hydrogen" covers the determination of the material resistance against compressed hydrogen. It is based on existing well-known and internationally recognised regulations, best practices and was developed together with (component-) manufacturers to provide a structured process for the evaluation of H_2 material compatibility.

The objective of the TÜV SÜD test standard P-003 is therefore, on the one hand, to create an evaluation basis to determine the resistance of materials against compressed hydrogen depending on the conditions of use of the component and, on the other hand, to provide information on the processing of materials for hydrogen applications.

fischer Edelstahlrohre GmbH

In the case of the company fischer Edelstahlrohre GmbH the TÜV SÜD Certification Body certifies that their longitudinal seam laser welded tubes acc. to DIN EN 10217-7, made of 1.4401/04, 1.4571 and 1.4435, comply with the requirements of the test standard P-003 in the following boundary conditions:

Tube geometry:	Round			
Diameter:	Ø 5 mm – Ø 205 mm			
Wall thickness:	0,3 mm – 4 mm			
Material:	1.4401	1.4404	1.4571	1.4435
H_2 operating temperature:	-253 °C - +300 °C	-253 °C - +400 °C	-253 °C - +400 °C	-253 °C - +400 °C
Heat treatment conditions:	Annealed / unannealed (W2R/W0)			
H_2 operating pressure:	≤ 90 MPa			

As a requirement of the certification process for austenitic stainless steels, several material tests for the material qualification were part of the assessment. Amongst others, tensile tests and hardness measurements were performed. In addition, aspects like the chemical composition, a weld seam examination and grain size measurement were taken into account. Austenitic stainless steels also have a tendency to form deformation martensite under external stresses which can influence the resistance against gaseous hydrogen. Therefore, so-called delta ferrite measurements were performed to characterize the base material and weld seam.

Besides the material evaluation, the certification also includes an initial audit of the company's production site. The complete production cycle was considered and the respective instructions and certificates, such as welding instructions and calibration certificates, were checked for their validity.

The issued certificate is valid for 3 years and annual surveillance audits are carried out to ensure that the necessary quality standards are applied continuously.

Manufacturers can show by the certification, that specific and critical product properties are independently reviewed and monitored by a third party.

Please note: The certification does not contain any statements on the design/dimensioning of components in terms of pressure and temperature. These aspects must be carried out by the respective customer for his application, considering the operating conditions and safety aspects.

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The following flow diagram shows the general steps of a certification according to the TÜV SÜD test standard P-003: