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Standard Test Method for Determination of the Susceptibility of Metallic Materials to Gaseous Hydrogen Embrittlement¹

This standard is issued under the fixed designation F 1459; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

^{e1} NOTE—Editorial changes throughout this test method.

1. Scope

1.1 This test method covers quantitative determination of the susceptibility of metallic materials to hydrogen embrittlement, when exposed to gaseous hydrogen, in any conditions.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Summary of Test Method

2.1 A thin disk of the metallic material to be tested is introduced as a membrane into a test cell and submitted to helium pressure to burst. The fracture will be caused only by mechanical overload, and no physical-chemical secondary action is involved because of the inert nature of helium. An identical disk of the same material is introduced in the same test cell and submitted to hydrogen pressure to burst. Metallic materials susceptible to hydrogen embrittlement will burst under a pressure below the helium burst pressure. Materials not susceptible will fracture under a pressure identical to the helium pressure. The ratio between the helium burst pressure (P_{He}) and the hydrogen burst pressure (P_{H_2}), P_{He}/P_{H_2} , will indicate the susceptibility of the material to hydrogen embrittlement.

3. Significance and Use

3.1 This test method will provide a guide for the choice of metallic materials for applications in which hydrogen in any

form (liquid, gaseous, monoatomic, etc.) produced by corrosion, electrolysis, chemical process, etc. is present.

3.2 The number corresponding to the P_{He}/P_{H_2} ratio will be a relative indication of the severity of degradation of the mechanical properties to be expected.

4. Apparatus

4.1 The basic system consists of the following:

4.1.1 *Test Cell*, as shown in Fig. 1, fabricated with type 316, 1/4-hard stainless steel.

4.1.2 The test cell is pressurized with hydrogen or helium through a pneumatic system, illustrated in Fig. 2.

5. Gases

5.1 *Helium*, purity 99.995 minimum, 6000-psig (41 600-kPa) cylinder.

5.2 *Hydrogen*, purity 99.995 minimum, 6000 psig (41 400 kPa).

6. Specimen Preparation

6.1 The specimens for the test cell, illustrated in Fig. 1, shall have a diameter of 58 mm (2.28 in.) and a thickness that varies between 0.25 and 1 mm (0.010 and 0.039 in.), most frequently 0.75 mm (0.030 in.).

6.2 Three sets of two specimens with identical dimensions and temper conditions shall be prepared for each test, and their dimensions shall be measured and recorded.

7. Procedure

7.1 Perform the burst test by helium pressure as follows:

7.1.1 Insert one of the sets of two identical disks from the three sets into the Test Cell (Item 9 of Fig. 2) after checking that the NBR O-rings (27 × 3.2 mm, 70A Durometer hardness) are in perfect condition. Then close the cell and tighten the bolts.

7.1.2 Close Valves 3, 5, and 11; open Valves 4, 6, and 7 and apply a vacuum of 10-2 torr for 3 min to eliminate air and residual test gases from the system. Close Valves 4, 6, and 7.

¹ This test method is under the jurisdiction of ASTM Committee F-7 on Aerospace and Aircraft and is the direct responsibility of Subcommittee F07.04 on Hydrogen Embrittlement.

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