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Steel — Measurement method for the evaluation of hydrogen embrittlement resistance of high strength steels —

Part 2:
Slow stain rate test

ICS: 77.040.99

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC *7, Steel*, Subcommittee SC 7 *Methods of testing (other than mechanical tests and chemical analysis)*.

The main changes compared to the previous edition are as follows:

A list of all parts in the ISO 16573 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www .iso .org/members .html.

Introduction

The mechanical properties of high strength steels, such as tensile strength, elongation and reduction of area would be degraded by the effect of hydrogen, known as hydrogen embrittlement, and the susceptibility of hydrogen embrittlement becomes greater with increasing the strength level of steels, This International Standard suggests a standardized test method for the evaluation of hydrogen embrittlement resistance of high strength steels, mainly ferritic base steels, using slow strain rate test.

Steel — Measurement method for the evaluation of hydrogen embrittlement resistance of high strength steels —

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1 Scope

This international standard method provides the evaluation method of the resistance to hydrogen embrittlement (i.e., hydrogen delayed fracture) using slow strain rate test with hydrogen pre-charged specimens. The amount of hydrogen absorbed in the specimens will be analysed quantitatively by thermal desorption analysis such as gas chromatography, mass spectrometry and so on. Hydrogen pre-charging methods are same as ISO 16573-1. This method addresses slow strain rate test to determine the susceptibility of hydrogen embrittlement of high strength steel, and is mainly applicable for the ferritic base steels. Testing methods for either smooth or notched specimens are also included.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 16573:2015, *Steel — Measurement method for the evaluation of hydrogen embrittlement resistance of high strength steels*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 6892-2, *Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Principle

This method is to evaluate material resistance to hydrogen embrittlement by slow strain rate test. Figure 1 shows schematic sequences for the overall testing method including hydrogen pre-charging (such as electrochemical method described in Part 1) Mechanical testing and Hydrogen analysis. Mechanical properties such as, yield strength, tensile strength, fracture strength, elongation to fracture and reduction of area are measured by applying tensile load at slow strain rate before and after hydrogen charging. Hydrogen contents in the specimen can be measured by thermal desorption analysis, and

the relationship between the diffusible hydrogen content and the degradation of mechanical properties can be obtained. Thermal desorption analysis of pre-charged but not deformed samples allows the quantification of the initial diffusible hydrogen content. However, thermal desorption analysis of pre-charged and deformed samples is only valid when the slow strain rate test is carried out using the plated samples. This method can provide at least qualitative comparison of the resistance to hydrogen embrittlement among several high strength steels having different microstructures or compositions.

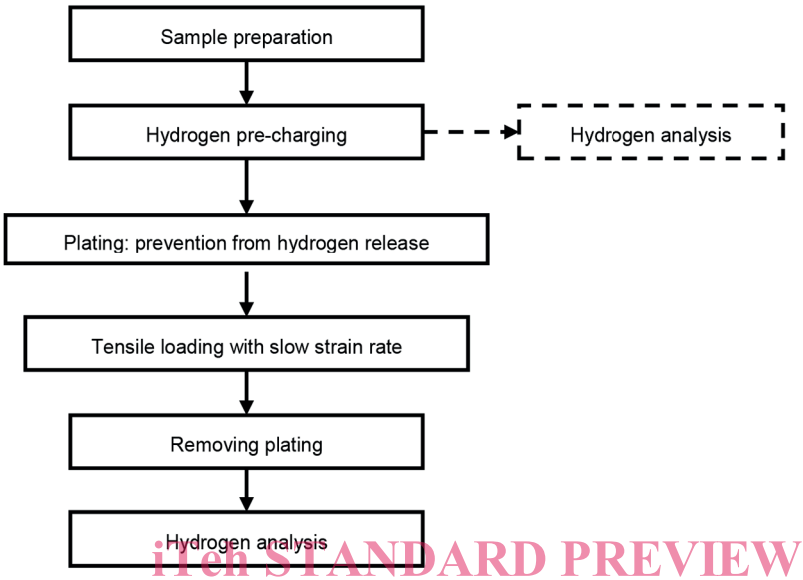


Figure 1 — Flow chart illustrating the test methods

5 Specimen preparation

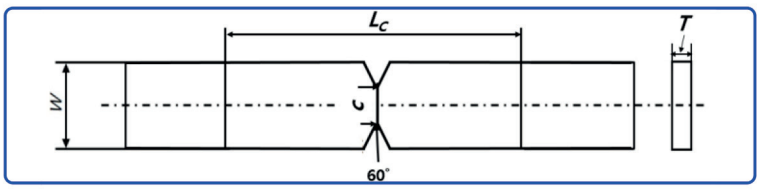
Tension specimens (bar type and flat type specimens) can be used for evaluation of hydrogen embrittlement.[1][2]

5.1 Bar type specimen

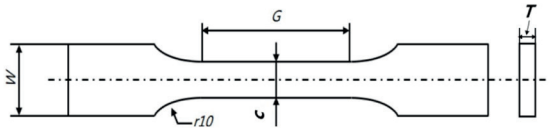
Both notched and smooth cylindrical specimens can be used. Detailed dimension of bar type specimen, is shown in clause 3 of ISO 16573-1:2015.[3]

5.2 Flat type specimen

Flat type specimens can also be used, and the dimension is shown in Figure 2. It is recommended to use specimens with 10 mm in grip width as a standard size. In case of flat type specimen, it can be referred to the Figure A.1 of ISO 6892-2 for grip with bolt.



a) Notched specimen



b) Smooth specimen

c/W	0.6
G/W	2.5
Lc/W	7

Key

W Width of grip ends
c Width
G Gauge length
r Radius
T Thickness ;
lower limit of thickness;0.1mm (see ISO 6892-1 Annex A)
upper limit of thickness ; width of parallel width 0.1 mm ≤ T≤ w

Figure 2 — Dimension of flat type specimens

6 Hydrogen charging methods

Hydrogen charging is performed by electrochemical method. Detailed procedures of hydrogen charging, are specified in clause 5 of ISO 16573-1:2015.

7 Preparation of electroplating solution and electroplating condition

The plating process is applied to prevent hydrogen release during the tensile loading. Requirement concerning preparation of electroplating solution and electroplating condition is specified in clause 5 of ISO 16573-1:2015.

8 Slow strain rate test

8.1 General

This test measures the loss of material strength and ductility in the hydrogen charged specimen as compared to the uncharged one, and determines which composition or microstructure reveals higher resistance to hydrogen embrittlement.[4]

Slow strain rate test can be performed by use of general tensile testing machines following the requirements of ISO 7500-1:2015, ISO 6892-1 and ISO 6892-2.

8.2 Procedures

Followings are the suggested method for the slow strain rate test.

a) Use adequate jig and tensile test system to apply uniaxial loading to the specimens Chamber with environmental controller can be used in SSRT if the behaviour of hydrogen pre-charged specimen at various environment should be considered. Here, environment may represent temperature, humidity and so on.