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

**Part 1:
Constant load test**

*Acier — Méthode de mesure pour l'évaluation de la résistance à la
fragilisation par l'hydrogène des aciers à haute résistance —*

Partie 1: Essai de charge constante



This document is a preview generated by ELS



COPYRIGHT PROTECTED DOCUMENT

© ISO 2020

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	1
5 Specimen preparation	2
6 Hydrogen charging methods	3
6.1 General.....	3
6.2 Cathodic charge method.....	3
6.2.1 Hydrogen charging solution.....	3
6.2.2 Hydrogen charging conditions.....	4
6.3 Hydrogen absorption in aqueous solution at free corrosion potential.....	4
6.4 Hydrogen absorption in atmospheric corrosion environments.....	4
6.5 Hydrogen absorption in high pressure hydrogen gas.....	4
7 Preparation of electroplating solution and electroplating condition	5
7.1 General.....	5
7.2 Electroplating solution.....	5
7.3 Electroplating conditions.....	5
8 Constant loading test	5
8.1 Constant loading test procedures.....	5
8.2 Presentation of the results.....	6
9 Post-test specimen treatment	8
10 Hydrogen thermal desorption analysis	9
10.1 General.....	9
10.2 Experimental apparatus (gas chromatograph).....	10
10.3 Experimental apparatus (mass spectrometry).....	10
11 Test report	10
Bibliography	11

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 17, *Steel*, Subcommittee SC 7, *Methods of testing (other than mechanical tests and chemical analysis)*.

This edition cancels and replaces the first edition (ISO 16573:2015), which has been technically revised. The main changes compared to the previous edition are as follows:

- the addition of a note to provide the definition of ρ as the radius of the notch bottom. The definition of r was unclear and was used in a different way in 2b).
- the temperature in [6.1](#) and [Clause 7](#) where different, the temperature below -50 °C is used;
- the addition of Figures of unbroken notched specimen and unbroken smooth specimen;
- the addition of research papers in Bibliography.

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 document suggests a standardized test method for the evaluation of hydrogen embrittlement resistance of high strength steels.

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

Part 1: Constant load test

1 Scope

This document provides a method for the evaluation of the resistance to hydrogen embrittlement (i.e. hydrogen delayed fracture) using constant loading test with hydrogen pre-charged specimens. The amount of hydrogen content absorbed in the specimens is analysed quantitatively by thermal desorption analysis such as gas chromatography, mass spectrometry and so on. In the case of hydrogen continuous charging such as hydrogen absorption in aqueous solution at free corrosion potential, hydrogen absorption in atmospheric corrosion environments and hydrogen absorption in high pressure hydrogen gas, the evaluation method is also briefly described. This method is mainly applicable to the evaluation of hydrogen embrittlement resistance of high strength steel bolts.

2 Normative references

There are no normative references in this document.

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 test method is used to evaluate material resistance to hydrogen embrittlement. [Figure 1](#) shows schematic sequences for a) hydrogen pre-charging method and b) hydrogen continuous charging method. For the hydrogen pre-charging method [see [Figure 1](#) a)], prepare a test specimen which has a higher hydrogen level by forcibly charging hydrogen into the specimen. Apply constant load to the hydrogen charged test specimen and measure the time to failure. By testing specimens containing various contents of diffusible hydrogen, which is mainly responsible for hydrogen embrittlement, the relationship between diffusible hydrogen content and times to failure can be obtained. Diffusible hydrogen content can be measured by thermal desorption analysis using the test specimen after failure. This method can provide at least qualitative comparison of the resistance to hydrogen embrittlement among several high strength steels having different microstructures or compositions. For the hydrogen continuous charging method [see [Figure 1](#) b)], a test specimen is loaded in one of the following three conditions:

- a) in aqueous solution at free corrosion potential;
- b) in atmospheric corrosion environments;