TECHNICAL REPORT

ISO/TR 20491

First edition
2019-02

Fasteners — Fundamentals of hydrogen embrittlement in steel fasteners

Fixations — Principes de la fragilisation par l'hydrogène pour les fixations en acier

Reference number
ISO/TR 20491:2019(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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 2 *Fasteners*, Subcommittee SC 14, *Surface coatings*.

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

High strength mechanical steel fasteners are broadly characterized by tensile strengths (R_m) above 1 000 MPa and are often used in critical applications such as in bridges, engines, aircraft, where a fastener failure can have catastrophic consequences. Preventing failures and managing the risk of hydrogen embrittlement (HE) is a fundamental consideration implicating the entire fastener supply chain, including: the steel mill, the fastener manufacturer, the coater, the application engineer, the joint designer, all the way to the end user. Hydrogen embrittlement has been studied for decades, yet the complex nature of HE phenomena and the many variables make the occurrence of fastener failures unpredictable. Researches are typically conducted under simplified and/or idealized conditions that cannot be effectively translated into *know-how* prescribed in fastener industry standards and practices. Circumstances are further complicated by specifications or standards that are sometimes inadequate and/or unnecessarily alarmist. Inconsistencies and even contradictions in fastener industry standards have led to much confusion and many preventable fastener failures. The fact that HE is very often mistakenly determined to be the *root cause* of failure as opposed to a *mechanism* of failure reflects the confusion.

Fasteners — Fundamentals of hydrogen embrittlement in steel fasteners

1 Scope

This document presents the latest knowledge related to hydrogen embrittlement, translated into *know-how* in a manner that is complete yet simple, and directly applicable to steel fasteners.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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/

3.1
hardness
resistance of a metal to plastic deformation, usually by indentation or penetration by a solid object (at the surface or in the core)

3.2
work hardening
increase of mechanical strength and *hardness* (3.1) when a metal is plastically deformed at ambient temperature (by rolling, drawing, stretching, sinking, heading, extrusion, etc.) also resulting in a decrease of ductility

3.3
heat treatment
process cycle (controlled heating, soaking and cooling) of a solid metal or alloy product, to obtain a controlled and homogeneous transformation of the material structure and/or to achieve desired physical or mechanical properties

Note 1 to entry: Quenching and tempering, annealing, case-hardening and stress relief are examples of heat treatment for fasteners.

3.4
quenching and tempering
QT
heat treatment (3.3) process of quench hardening comprising austenitizing and fast cooling, under conditions such that the austenite transforms more or less completely into martensite (and possibly into bainite), followed by a reheat to a specific temperature for a controlled period, then cooling, in order to achieve the required level of physical or mechanical properties