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Fasteners - Fundamentals of hydrogen embrittlement in steel fasteners (ISO/TR 20491:2019)

Fixations - Principes de la fragilisation par l'hydrogène pour les fixations en acier (ISO/TR 20491:2019)

Mechanische Verbindungselemente - Grundlagen der Wasserstoffversprödung in Verbindungselementen aus Stahl (ISO/TR 20491:2019)

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Foreword

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This document was prepared by Technical Committee ISO/TC 2 *Fasteners*, Subcommittee SC 14, *Surface coatings*.

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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.

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Fasteners — Fundamentals of hydrogen embrittlement in steel fasteners

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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

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