SVENSK STANDARD
SS-EN ISO 7539-9:2008

Fastställd/Approved: 2008-04-21
Publicerad/Published: 2009-01-30
Utgåva/Edition: 1
Språk/Language: engelska/English
ICS: 77.060

Korrosion hos metaller och legeringar – Spänningskorrosionsprovning – Del 9: Framtagning och användning av provstavar med sprickanvisning för provning under ökande belastning eller ökande töjning (ISO 7539-9:2003)

Corrosion of metals and alloys – Stress corrosion testing – Part 9: Preparation and use of pre-cracked specimens for tests under rising load or rising displacement (ISO 7539-9:2003)

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ISO 7539-9 finns tidigare utgiven som svensk standard med beteckning SS-ISO 7539-9, utgåva 1.

The European Standard EN ISO 7539-9:2008 has the status of a Swedish Standard. This document contains the official English version of EN ISO 7539-9:2008.

ISO 7539-9 has been implemented and published as a Swedish Standard with the designation SS-ISO 7539-9, edition 1.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 7539-9

April 2008

ICS 77.060

English Version

Corrosion of metals and alloys - Stress corrosion testing - Part 9: Preparation and use of pre-cracked specimens for tests under rising load or rising displacement (ISO 7539-9:2003)

Corrosion des métaux et alliages - Essais de corrosion sous contrainte - Partie 9: Préparation et utilisation des éprouvettes préfissurées pour essais sous charge croissante ou sous déplacement croissant (ISO 7539-9:2003)

Korrosion von Metallen und Legierungen - Prüfung der Spannungsrisskorrosion - Teil 9: Vorbereitung und Anwendung von angerissenen Proben für die Prüfung mit zunehmender Kraft oder zunehmender Verformung (ISO 7539-9:2003)

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Ref. No. EN ISO 7539-9:2008: E

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Foreword

The text of ISO 7539-9:2003 has been prepared by Technical Committee ISO/TC 156 "Corrosion of metals and alloys" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 7539-9:2008 by Technical Committee CEN/TC 262 "Metallic and other inorganic coatings" the secretariat of which is held by BSI.

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The text of ISO 7539-9:2003 has been approved by CEN as a EN ISO 7539-9:2008 without any modification.

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Corrosion of metals and alloys — Stress corrosion testing —

Part 9: Preparation and use of pre-cracked specimens for tests under rising load or rising displacement

1 Scope

1.1 This part of ISO 7539 covers procedures for designing, preparing and using pre-cracked specimens for investigating the susceptibility of metal to stress corrosion cracking by means of tests conducted under rising load or rising displacement. Tests conducted under constant load or constant displacement are dealt with in ISO 7539-6.

The term “metal” as used in this part of ISO 7539 includes alloys.

1.2 Because of the need to confine plasticity to the crack tip, pre-cracked specimens are not suitable for the evaluation of thin products such as sheet or wire and are generally used for thicker products including plate, bar and forgings. They can also be used for parts joined by welding.

1.3 Pre-cracked specimens may be stressed quantitatively with equipment for application of a monotonically increasing load or displacement at the loading points.

1.4 A particular advantage of pre-cracked specimens is that they allow data to be acquired from which critical defect sizes, above which stress corrosion cracking may occur, can be estimated for components of known geometry subjected to known stresses. They also enable rates of stress corrosion crack propagation to be determined.

1.5 A principal advantage of the test is that it takes into account the potential impact of dynamic straining on the threshold for stress corrosion cracking.

1.6 At sufficiently low loading rates, the K_{ISCC} determined by this method can be less than or equal to that obtained by constant load or displacement methods and can be determined more rapidly.

2 Normative references

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

ISO 7539-1:1987, *Corrosion of metals and alloys — Stress corrosion testing — Part 1: General guidance on testing procedures*

ISO 7539-6:—[1)], *Corrosion of metals and alloys — Stress corrosion testing —Part 6: Preparation and use of pre-cracked specimens for tests under constant load or constant displacement*

1) To be published. (Revision of ISO 7539-6:1989)

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ISO 7539-7:—[2)], *Corrosion of metals and alloys — Stress corrosion testing — Part 7: Slow strain rate testing*

ISO 11782-2:1998, *Corrosion of metals and alloys — Corrosion fatigue testing — Part 2: Crack propagation testing using precracked specimens*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7539-6 as well as the following apply.

3.1
rate of change of crack opening displacement at loading plane
$\dot{V}_{LL}$
deflection at the loading point access measured over a fixed period

3.2
stress intensity factor at crack initiation
$K_{\text{I-init}}$
stress intensity applied at the commencement of measurable crack growth

3.3
range of stress intensity factor
ΔK_{f}, in fatigue
algebraic difference between the maximum and minimum stress intensity factors in a cycle

3.4
displacement rate
$\text{d}q/\text{d}t$
rate of increase of the deflection either measured at the loading point axis or away from the loading line

4 Principle

4.1 The use of pre-cracked specimens acknowledges the difficulty of ensuring that crack-like defects, introduced during either manufacture or subsequent service, are totally absent from structures. Furthermore, the presence of such defects can cause a susceptibility to stress corrosion cracking, which in some materials (e.g. titanium) may not be evident from tests on smooth specimens under constant load. The principles of linear elastic fracture mechanics can be used to quantify the stress situation existing at the crack tip in a pre-cracked specimen or structure in terms of the plane strain-stress intensity.

4.2 The test involves subjecting a specimen, in which a crack has been developed from a machined notch by fatigue, to an increasing load or displacement during exposure to a chemically aggressive environment. The objective is to quantify the conditions under which environmentally-assisted crack extension can occur in terms of the threshold stress intensity for stress corrosion cracking, K_{ISCC}, and the kinetics of crack propagation.

4.3 Tests may be conducted in tension or in bending. The most important characteristic of the test is the low loading/displacement rate that is applied.

4.4 Because of the dynamic straining which is associated with this method, the data obtained may differ from those obtained for pre-cracked specimens with the same combination of environment and material when the specimens are subjected to static loading only.

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2) To be published. (Revision of ISO 7539-7:1989)

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4.5 The empirical data can be used for design or life prediction purposes in order to ensure either that the stresses within large structures are insufficient to promote the initiation of environmentally-assisted cracking at whatever pre-existing defects may be present or that the amount of crack growth which would occur within the design life or inspection periods can be tolerated without the risk of unstable failure.

4.6 Stress corrosion cracking is influenced by both mechanical and electrochemical driving forces. The latter can vary with crack depth, opening or shape because of variations in crack-tip chemistry and electrode potential and may not be uniquely described by the fracture mechanics stress intensity factor.

4.7 The mechanical driving force includes both applied and residual stresses. The possible influence of the latter should be considered in both laboratory testing and application to more complex geometries. Gradients in residual stress in a specimen may result in non-uniform crack growth along the crack front.

4.8 K_{ISCC} is a function of the environment, which should simulate that in service, and of the conditions of loading.

5 Specimens

5.1 General

5.1.1 A wide range of standard specimen geometries of the type used in fracture toughness tests may be used. Those most commonly used are described in ISO 7539-6. The particular type of specimen used will be dependent upon the form, the strength and the susceptibility to stress corrosion cracking of the material to be tested and also on the objective of the test.

5.1.2 A basic requirement is that the dimensions be sufficient to maintain predominantly triaxial (plane strain) conditions in which plastic deformation is limited in the vicinity of the crack tip. Experience with fracture toughness testing has shown that for a valid K_{Ic} measurement, both the crack length, a, and the thickness, B, shall be not less than

$$2{,}5\left(\frac{K_{\mathrm{Ic}}}{R_{\mathrm{p0,2}}}\right)^2$$

and that, where possible, larger specimens where both a and B are at least

$$4\left(\frac{K_{\mathrm{Ic}}}{R_{\mathrm{p0,2}}}\right)^2$$

shall be used to ensure adequate constraint.

From the view of fracture mechanics, a minimum thickness from which an invariant value of K_{ISCC} is obtained cannot currently be specified. The presence of an aggressive environment during stress corrosion may reduce the extent of plasticity associated with fracture and hence the specimen dimensions needed to limit plastic deformation. However, in order to minimize the risk of inadequate constraint, it is recommended that similar criteria to those employed during fracture toughness testing used regarding specimen dimensions, i.e. both a and B shall be not less than

$$2{,}5\left(\frac{K_{\mathrm{I}}}{R_{\mathrm{p0,2}}}\right)^2$$