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Standard Practice for
Slow Strain Rate Testing to Evaluate the Susceptibility of Metallic Materials to Environmentally Assisted Cracking[1]

This standard is issued under the fixed designation G129; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers procedures for the design, preparation, and use of axially loaded, tension test specimens and fatigue pre-cracked (fracture mechanics) specimens for use in slow strain rate (SSR) tests to investigate the resistance of metallic materials to environmentally assisted cracking (EAC). While some investigators utilize SSR test techniques in combination with cyclic or fatigue loading, no attempt has been made to incorporate such techniques into this practice.

1.2 Slow strain rate testing is applicable to the evaluation of a wide variety of metallic materials in test environments which simulate aqueous, nonaqueous, and gaseous service environments over a wide range of temperatures and pressures that may cause EAC of susceptible materials.

1.3 The primary use of this practice is to furnish accepted procedures for the accelerated testing of the resistance of metallic materials to EAC under various environmental conditions. In many cases, the initiation of EAC is accelerated through the application of a dynamic strain in the gauge section or at a notch tip or crack tip, or both, of a specimen. Due to the accelerated nature of this test, the results are not intended to necessarily represent service performance, but rather to provide a basis for screening, for detection of an environmental interaction with a material, and for comparative evaluation of the effects of metallurgical and environmental variables on sensitivity to known environmental cracking problems.

1.4 Further information on SSR test methods is available in ISO 7539 and in the references provided with this practice (**1-6**).[2]

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Furthermore, in some cases, special facilities will be required to isolate these tests from laboratory personnel if high pressures or toxic chemical environments, or both, are utilized in SSR testing.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products
B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
D1193 Specification for Reagent Water
E4 Practices for Force Verification of Testing Machines
E6 Terminology Relating to Methods of Mechanical Testing
E8 Test Methods for Tension Testing of Metallic Materials
E399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness K_{Ic} of Metallic Materials
E602 Test Method for Sharp-Notch Tension Testing with Cylindrical Specimens (Withdrawn 2010)[4]
E616 Terminology Relating to Fracture Testing (Discontinued 1996) (Withdrawn 1996)[4]
E647 Test Method for Measurement of Fatigue Crack Growth Rates
E1681 Test Method for Determining Threshold Stress Intensity Factor for Environment-Assisted Cracking of Metallic Materials
G15 Terminology Relating to Corrosion and Corrosion Testing (Withdrawn 2010)[4]
G49 Practice for Preparation and Use of Direct Tension Stress-Corrosion Test Specimens
G111 Guide for Corrosion Tests in High Temperature or High Pressure Environment, or Both

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[1] This practice is under the jurisdiction of ASTM Committee G01 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.06 on Environmentally Assisted Cracking.

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[2] The boldface numbers in parentheses refer to a list of references at the end of this standard.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] The last approved version of this historical standard is referenced on www.astm.org.

G142 Test Method for Determination of Susceptibility of Metals to Embrittlement in Hydrogen Containing Environments at High Pressure, High Temperature, or Both

2.2 *ISO Standard:*[5]

ISO 7539 Part 7, Slow Strain Rate Testing

3. Terminology

3.1 For purposes of this practice the following terms are defined:

3.2 *control environment*—an environment in which SSR specimens are tested that has been shown not to cause EAC or excessive corrosion of the material. The results of tests conducted in this environment may be used as a basis for comparison with corresponding tests conducted in the test environment(s), usually at the same temperature as the test environment.

3.3 *environmentally assisted cracking (EAC)*— cracking of a material caused by the combined effects of stress and the surrounding environment, for example, stress corrosion cracking, hydrogen embrittlement cracking, sulfide stress cracking and liquid metal embrittlement.

3.4 *slow strain rate (SSR)*—a dynamic slowly increasing strain imposed by an external means on the gauge section or notch tip of a uniaxial tension specimen or crack tip of a fatigue pre-cracked specimen for purposes of materials evaluation. The strain rate for a plain or smooth specimen (given in units of extension divided by the gage length per unit time) or the strain rate at a notch tip of a notched tension specimen or crack tip of a fatigue pre-cracked specimen is applied through the application of a slow constant extension rate (given in units of extension per unit time). The slow constant extension rate produces a gauge section strain rate, which is usually in the range from 10^{-4} to $10^{-7}/s^{-1}$. Rigorous analytical solutions of the local strain rate at a notch tip of a tension specimen or at a crack tip of a fatigue pre-cracked specimen are not available. The average or local strain rate should be slow enough to allow time for certain corrosion processes to take place, but fast enough to produce failure or cracking of the specimen in a reasonable period of time for evaluation purposes. In cases where extremely slow strain rates are being utilized (that is, 10^{-7} to 10^{-8} $/s^{-1}$ for smooth tension specimens), an interrupted SSR test can be employed whereby the specimen is strained into the plastic range at the intended strain rate followed by more rapid straining to failure.

3.5 The terminology found in Test Methods and Definitions A370, Test Method B557, and Test Method E602 along with the definitions given in Terminologies E6, E616, and G15 shall apply to the terms used in this practice.

4. Summary of Practice

4.1 This practice describes the use of tension and fatigue pre-cracked specimens for the determination of resistance to EAC of metallic materials. The procedure involves the application of very slow strain rates, which are achieved by a constant extension rate on the specimen while monitoring load and extension of the specimen. The SSR test always produces fracture of the test specimen. Typically, the results from tests conducted in the test environment are compared to corresponding test results for the same material in a control environment. The degree of susceptibility to EAC is generally assessed through observation of the differences in the behavior of the material in tests conducted in a test environment from that obtained from tests conducted in the control environment. For smooth tension specimens, either changes in time-to-failure, or specimen ductility, or visual indications of EAC, or often some combination of these methods, are utilized in determining susceptibility to EAC. For notched tension specimens, changes in the notch tensile strength and visual indications of EAC on the primary fracture surface are used in determining susceptibility to EAC. For fatigue pre-cracked specimens, changes in the threshold stress intensity factor and visual indications of EAC on the primary fracture surface are used in determining susceptibility to EAC.

5. Significance and Use

5.1 The slow strain rate test is used for relatively rapid screening or comparative evaluation, or both, of environmental, processing or metallurgical variables, or both, that can affect the resistance of a material to EAC. For example, this testing technique has been used to evaluate materials, heat treatments, chemical constituents in the environment, and temperature and chemical inhibitors.

5.2 Where possible, the application of the SSR test and data derived from its use should be used in combination with service experience or long-term EAC data, or both, obtained through literature sources or additional testing using other testing techniques. In applications where there has been little or no prior experience with SSR testing or little EAC data on the particular material/environment combination of interest, the following steps are recommended:

5.2.1 The SSR tests should be conducted over a range of applied extension rates (that is, usually at least one order of magnitude in applied extension rate above and below 10^{-6} in/s (2.54×10^{-5} mm/s) to determine the effect of strain rate or rate of increase of the stress or stress intensity factor on susceptibility to EAC.

5.2.2 Constant load or strain EAC tests should also be conducted in simulated service environments, and service experience should be obtained so that a correlation between SSR test results and anticipated service performance can be developed.

5.3 In many cases the SSR test has been found to be a conservative test for EAC. Therefore, it may produce failures in the laboratory under conditions which do not necessarily cause EAC under service application. Additionally, in some limited cases, EAC indications are not found in smooth tension SSR tests even when service failures have been observed. This effect usually occurs when there is a delay in the initiation of localized corrosion processes. Therefore, the suggestions given in 5.2 are strongly encouraged.

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[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

5.4 In some cases, EAC will only occur in a specific range of strain rates. Therefore, where there is little prior information available, tests should be conducted over a range of strain rates as discussed in 5.2.

6. Apparatus

6.1 *Testing Machines:*

6.1.1 Tension testing machines used for SSR testing shall conform to the requirements of Practices E4.

6.1.2 The loads used in SSR testing shall be within the calibrated load ranges of the testing machine in accordance with Practices E4.

6.1.3 The testing machines used for SSR testing shall be capable of accurate application of extension rates in the range of interest for evaluation of EAC. These extension rates are usually between 10^{-4} and 10^{-7} in/s (2.54×10^{-3} and 2.54×10^{-6} mm/s).

6.1.4 An example of a SSR testing machine setup including the load frame, instrumentation, and local test cell is shown in Fig. 1. Another example of a SSR machine setup with a metal test cell or autoclave can be found in Test Method G142. The test specimen is loaded with a grip assembly and load frame inside the autoclave. The autoclave is equipped with a tensile loading feed-through to provide transmission of loads from the tensile machine to the specimen using a pull rod in combination with the feed-through. Some SSR testing machines may be able to test more than one specimen at a time in a particular environment. However, this type of machine should only be used if it can be shown that failure of one or multiple specimens does not influence the behavior of the other specimens.

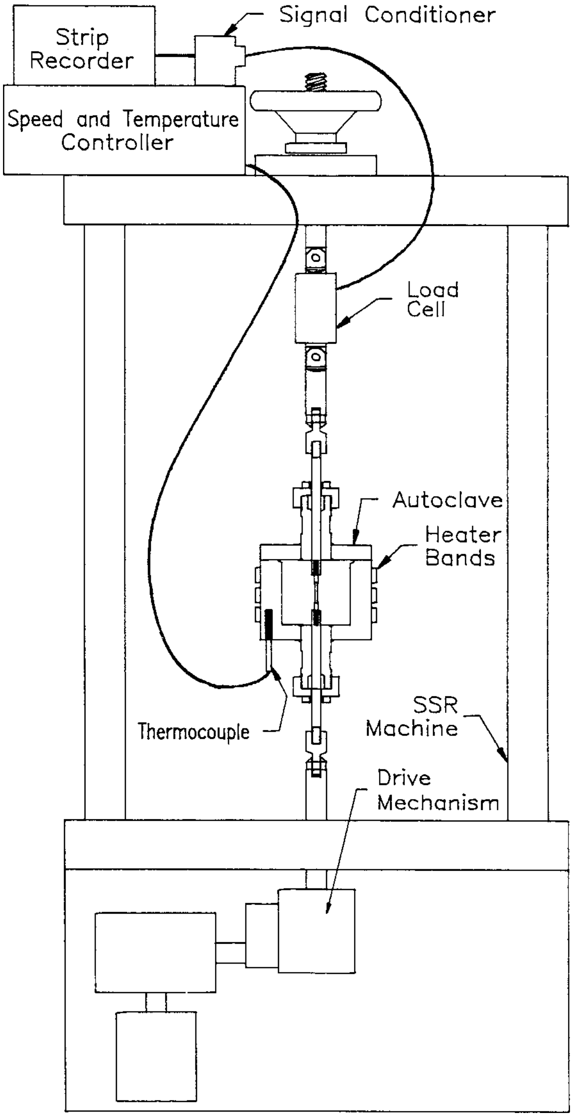

FIG. 1 An Example of a SSR Testing Machine.

6.2 *Gripping Devices*—The types of gripping devices that may be used to transmit the applied load from the testing machine to the tension specimen conform to those described in Test Methods E8. Alignment procedures are provided in Test Method E8.

6.3 *Clevices and Fixtures*—A loading clevis that is suitable for loading pre-cracked compact specimens should conform with clevices described in Test Method E399. A bend test fixture for loading pre-cracked bend specimens should conform with bend fixtures described in Test Method E399. It is important that attention be given to achieving good load train alignment through careful machining of all clevices and fixtures.

6.4 *Displacement Gauges*—An electronic crack mouth opening displacement (CMOD) gauge attached to the front face of pre-cracked specimens and spanning the crack starter notch to detect crack growth during testing should be in accordance with displacement gauges described in Test Method E399. Alternatively, the displacements can be transferred outside the environmental test cell in the case of tests conducted in high temperature or severely corrosive environments. An extensometer placed outside the test cell can be used to detect the crack growth. A displacement gauge can be attached to the specimen at alternative locations to detect crack growth if the proper compliance-crack length relationship has been determined for the measurement location on the specimen.

6.5 *Environmental Test Cells*—Test cells shall be constructed in a manner to facilitate handling and monitoring of the test environment while allowing testing of the tension specimen. This will require the incorporation of a suitable low-friction feed-through in the vessel for application of load to the test specimen. Additionally, the test cell shall be able to safely contain the test environment with adequate accommodation for the temperature and pressure under which the SSR tests will be conducted.

6.5.1 Test cells shall be effectively inert (that is, have a low corrosion rate and not susceptible to EAC in the test environment so that they do not react with or contaminate the environment).

6.5.2 The test cell size should be such that a solution volume-to-exposed specimen surface area is not less than 30 mL/cm^2.

6.6 *Galvanic Effects*—Eliminate galvanic effects between the test specimen and various metallic components of the gripping fixtures and test cell by electrically insulating or isolating these components unless it is specifically desired to simulate galvanic interactions found in service conditions and their effects on EAC. Check electrical isolation with an ohmmeter, if required, prior to testing. It should be noted that, in some cases, electrical insulation may be bridged by deposits of conductive or semiconductive solid corrosion products during the test, thereby introducing galvanic effects into the SSR test.

7. Reagents

7.1 As is the case with most types of corrosion testing, it is necessary to provide a reproducible chemical environment so that consistent test results can be obtained. This is particularly true in the evaluation for EAC of metallic materials. Therefore, where a test environment is being established from laboratory chemicals, chemicals of reagent grade purity with known contaminant levels are recommended.

7.1.1 When aqueous test environments are being prepared, only distilled or deionized water described in Specification D1193 (Type IV) should be used.

7.2 In some cases, it is also necessary to conduct SSR tests in actual service environments in situ, in retrieved samples of service environments, or in simulations of service environments.

7.3 When conducting SSR tests, the chemical nature of the test environment should be characterized with respect to its chemical composition, impurity content, and other necessary information to characterize the possible role of its constituents on EAC behavior.

8. Test Specimens

8.1 The tension specimens used for EAC evaluation with the SSR test should conform to the dimensions and guidelines provided in Test Method E8. However, in some cases, the material size, configuration and form, or the confines of various environmental test cells may limit the actual dimensions of the test specimens. In such cases, where non-standard specimens must be utilized, the specimen geometry and dimensions shall be fully described. Care should be taken to only compare the results obtained from specimens with similar geometries.

8.2 In most cases, subsize tension specimens are utilized for SSR tests. Therefore, extreme care must be taken in machining these specimens and surface finish is extremely critical to SSR test results.

8.2.1 To produce tension specimens which have surfaces with minimal cold working, it is recommended that the total metal removed in the last two machining passes be limited to a total of 0.05 mm and have a surface finish of 0.25-µm (10-µin.) rms or better. The method of final machining of the gauge section should be by grinding (not turning) to completely avoid localized grooves and cold-worked areas. Special care should be taken to machine specimens with minimum run-out to minimize bending stresses during testing.

8.3 In some cases, notched tension test specimens have been used (*1*) to localize the failure in regions of microstructural interest such as welds or heat-affected zones, (*2*) to induce local crevice sites for acceleration of EAC or (*3*) to accelerate hydrogen entry into the specimen due to high hydrostatic stresses for acceleration of hydrogen embrittlement or sulfide stress cracking. In addition, notched tension specimens have been used in SSR tests to provide an estimate of the threshold stress intensity factor for EAC (**3**). In using such specimens, it is important to conduct the control environment tests using the same specimen geometry and design.

8.4 With the exception of the procedures for minimization of the effects of cold working as given in 8.2.1, the tension specimens should be prepared for testing in accordance with procedures specified in Practice G49 and Test Method E8.

8.5 The fatigue pre-cracked specimens used for EAC evaluation with the SSR test should conform to the size requirements and guidelines developed for plane strain conditions in Test Method E399 or the size requirements for predominately linear elastic conditions as stated in Test Method E647. However, in some cases, the material size, configuration, and form, or the confines of various environmental test cells, may limit the actual dimensions of the test specimens. In such cases, where non-standard specimens must be utilized, the specimen geometry and dimensions shall be fully described. Care should be taken to only compare the results obtained from specimens with similar configurations.

8.5.1 The dimensional tolerances and surface finishes should be according to Test Method E399.

8.5.2 Low stress fatigue pre-cracking should be conducted in accordance with procedures in Test Method E1681.

8.5.3 Side-grooved specimens may be used to increase the through-thickness constraint of the specimen and promote straight fronted crack growth with some materials and some environments. This may be desirable if crack growth rate information is to be obtained. The depth of the side-grooves for a particular material can be found by trial and error, however, a total thickness reduction of 20% has been found to be effective for many materials. Any angle of side groove less than 90° is acceptable and the root radius should be less than 0.4 mm (0.016 in). It may be necessary to fatigue pre-crack the specimens before side-grooving in order to produce nearly-straight pre-crack fronts. The user should exercise caution when using side-grooved specimens in aggressive environments.

8.6 The test specimen should be degreased and cleaned prior to testing. In the case of fatigue pre-cracked specimens, the specimen should be degreased and cleaned prior to fatigue cracking and care should be taken not to contaminate the specimen prior to testing.

9. Test Environment

9.1 The SSR test is a comparative evaluation and therefore shall be conducted in at least two environments: (*1*) one in which the material(s) under evaluation are not susceptible to EAC (control environment), and (*2*) the other(s) in which the resistance to EAC of the material(s) is being determined.

9.1.1 Examples of some control environments for most metallic materials are dry air, dry inert gases (He or Ar), silicon oil, vacuum or, in some cases, dry N_2 gas.

9.2 For SSR tests of long duration and for tests involving low concentrations of reactive constituents or highly reactive constituents, care should be taken to monitor the test environment for depletion or concentration of chemical species, or both, as changes in these parameters could significantly affect or alter the EAC results.

9.2.1 It may be desirable to correct observed changes in the test environment in cases where the service environment would be expected to have constant composition. In these cases, either the gaseous or liquid constituents, or both, of the test environment may have to be replenished or changed during the period of the test.

9.3 SSR tests involving high temperature or high pressure environments, or both, conform with procedures provided in Guide G111.

10. Test Procedure

10.1 *Measurement of Dimensions of Test Specimens*—Measure the dimensions of the smooth tension specimens' gauge length and cross section in accordance with the requirements of Test Method E8. Measure the dimensions of the notched tension specimens' notch tip radius, notch diameter, and shoulder diameter in accordance with Test Method E602. Measure the dimensions of the pre-cracked specimens' thickness, width, and crack length in accordance with Test Method E399.

10.2 *Selection of Strain Rate Range*— Strain rate can affect the resistance of the material to EAC (denoted here in terms of the specimen ductility, that is, reduction in area) as schematically shown in Fig. 2 (**4**). Therefore, exercise care in the selection of the strain rate used for materials evaluation. If no data are available, choose a range of extension rates in the range from 10^{-4} to 10^{-7} in/s (2.54×10^{-3} and 2.54×10^{-6} mm/s) for screening tests so that the effects of extension rate on EAC can be determined. Most SSR tests, however, are conducted in the range of extension rates from 10^{-5} to 10^{-7} in/s (2.54×10^{-4} and 2.54×10^{-6} mm/s).

10.2.1 Define the strain rate for a smooth tension specimen in accordance with Test Method E8.

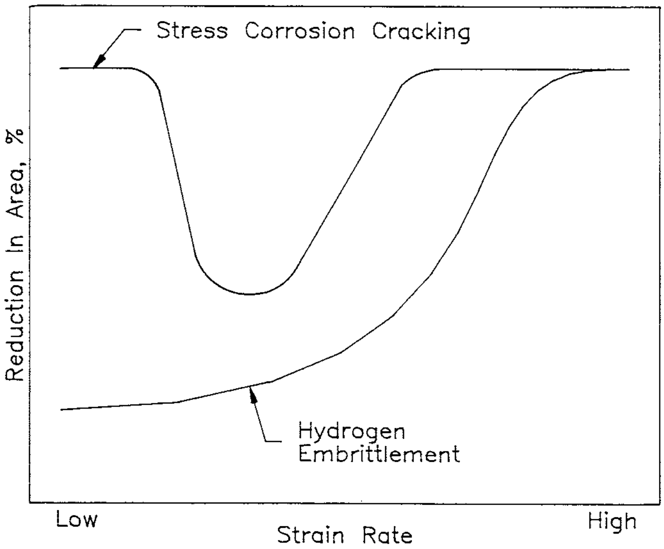

FIG. 2 Schematic of Strain Rate Range.

10.3 *Recording of Test Data:*

10.3.1 Upon first application of the load to the specimen, monitor both the applied load and crosshead displacement (or CMOD).

10.3.2 Use suitable monitoring methods that are capable of providing a sufficiently continuous record of load and crosshead displacement (or CMOD) throughout the duration of the test. It is usually acceptable, in most cases, to approximate specimen extension based on the extension rate and the test duration if suitable calibration of the test system extension rate has been made under load prior to SSR testing. For cases where extreme precision in specimen elongation measurements is required, an extensometer attached directly to the gauge section of the tension specimen may be required.

10.3.3 Monitoring of the corrosion potential of the specimen can provide information that is useful in interpretation of SSR test results. This is particularly true in cases where SSR test results are being compared to service experience where actual potential data have been obtained. It may also be advisable to control SSR test specimen potential, in some cases, to help more fully simulate these service conditions.

10.4 *Impressed Current, Potential, Galvanic Coupling*—Impressed current, potential, or galvanic coupling may be utilized to simulate service conditions or accelerate or retard the effects of EAC. In these cases, care must be taken to properly establish and record the various test parameters. Furthermore, consideration should be given to the possibility of corrosive damage that may have occurred to the specimen by exposure to the test environment prior to the initiation of the SSR test.

11. Evaluation of EAC Resistance Based on SSR Tests

11.1 The test results to be used for the evaluation of resistance of the material to EAC in SSR testing may depend largely on the intended application and service performance. As a minimum, the following ratios shall be utilized in evaluating SSR test data for a particular extension rate:

11.1.1 *Time-to-Failure Ratio (RTTF)*—The ratio of time-to-failure determined for the material in the test environment (TTF_e) to the corresponding value determined in the control environment (TTF_c).

$$RTTF = TTF_e/TTF_c \tag{1}$$

11.1.2 *Plastic Elongation Ratio (RE)*— The ratio of plastic elongation determined for the material in the test environment (E_e) to the corresponding value determined in the control environment (E_c) where plastic elongation is approximated to be the difference in crosshead displacement from the onset of specimen yielding to crosshead displacement at specimen fracture (see Fig. 3).

$$RE = E_e/E_c \tag{2}$$

The use of plastic elongation instead of total elongation minimizes variabilities between test results from differences in test machine compliance, which are most significant in the elastic region of the load displacement curve.

11.1.3 *Reduction in Area Ratio (RRA)*— The ratio of reduction in area after fracture for the specimen in the test environment (RA_e) to the corresponding value determined in the control environment (RA_c).

$$RRA = RA_e / RA_c \quad (3)$$

11.1.4 *Notch Tensile Strength Ratio (RNTS)*—The ratio of the notch tensile strength determined for the material in the test environment (NTS_e) to the corresponding value determined in the control environment (NTS_c).

$$RNTS = NTS_e / NTS_c \quad (4)$$

11.1.5 *Plane Strain Threshold Stress Intensity Factor Ratio*—The ratio of the plane strain EAC threshold stress intensity factor determined for the material in the test environment (K_{IEAC}) to the plane strain fracture toughness (K_{IC}) determined for the material in the control environment.

$$K_{IEAC} / K_{IC} \quad (5)$$

11.1.5.1 The specimen size is sufficient to meet the requirements for plane strain conditions as described in Test Method E399. K_{IEAC} and K_{IC} are determined in accordance with the 5 % secant offset procedure outlined in Test Method E399. If side-grooved specimens are used, then the specimen thickness is replaced by an effective specimen thickness as defined in Test Method E1681.

11.1.6 *Threshold Stress Intensity Factor Ratio*—The ratio of the EAC threshold stress intensity factor determined for the material in the test environment (K_{EAC}) to the fracture toughness (K_C) determined for the material in the control environment.

$$K_{EAC} / K_C \quad (6)$$

11.1.6.1 The specimen size is sufficient to meet the requirements for linear elastic conditions as described in Test Method E647. K_{EAC} and K_C are determined in accordance with the 5 % secant offset procedure outlined in Test Method E399. If side-grooved specimens are used, then the specimen thickness is replaced by an effective specimen thickness as defined in Test Method E1681. Both K_{EAC} and K_C may be specimen thickness dependent.

11.2 In all cases, evaluation of the SSR ratios (described in 11.1) for indication of EAC shall be based on the decrease in the value of the SSR ratios from unity. Therefore, to maximize EAC resistance, it is desirable to obtain values of SSR ratios as close to unity as possible. Lower values of SSR ratios generally indicate increasing susceptibility to EAC. However, there have been reported cases where decreasing SSR ratios have been observed in smooth tension tests without indications of EAC. These cases have usually been related to environments which can produce localized corrosion or hydrogen charging of the test specimen which produces a decrease in specimen ductility without producing brittle cracking. In these cases, the procedures given in 11.3 are recommended for evaluation of the material susceptibility to EAC.

11.3 It is recommended that careful visual examination of the fracture surface and gauge section areas be conducted on fractured smooth tension specimens which have SSR ratios less than one. This examination will assist in the identification of possible evidence of EAC on the primary fracture surface and secondary cracking in the gauge section of the specimen. Evidence of EAC can usually be obtained through low-power (10 to 50×) visual examination, metallographic sectioning, and high-power (50×) optical or scanning electron microscopy. The results of this examination along with the methods employed should be recorded.

11.4 Other test results that may be useful in the evaluation of EAC susceptibility are fracture energy (area under the stress-strain curve), ultimate tensile strength, strain to crack initiation, or crack velocity, or a combination thereof.

11.4.1 The strain prior to crack initiation can often be determined by visual or electrochemical monitoring, of the SSR specimen during testing. Electrochemical monitoring typically shows spikes (rapid increases in corrosion current of short duration) in the corrosion current at controlled potential or transients in potential under open-circuit conditions corresponding to crack initiation events.

11.4.2 Crack velocity estimates can be made by measuring the SSC crack lengths in the gauge section of the tension specimen and by dividing this value by the time that elapsed from the crack initiation event until failure of the specimen. It should be realized that these are average crack velocity estimates since (*1*) the stress is changing during the SSR test, (*2*) the final fracture is assumed to be very fast and can be neglected, and (*3*) the stress and stress intensity are changing during the test duration.

11.5 Both K_{IEAC} and K_{EAC} measured using the SSR test method should not be used to estimate the relationship between the failure stress and defect size of a material in service conditions without establishing a correlation between SSR test results and the anticipated performance of the material in service. It is recommended that long term static tests on pre-cracked specimens be conducted on the identical material and identical environment to establish this correlation.

12. Report

12.1 Report the following information for all SSR tests:

12.1.1 Material characterization including chemical composition, mechanical properties from conventional tests, product form, heat treatment, section size, and sampling procedures.

12.1.2 Specimen characterization including orientation, type, size, number of specimens, and surface preparation.

12.1.3 Initial extension rate and pre-load.

12.1.4 Documentation of the test environment, as applicable, including pH, flow rate, or agitation; aeration/deaeration; temperature; pressure; chemical constituents; chemical analysis; galvanic coupling; impressed current or potential; and open-circuit potential.

12.1.5 The SSR test results including load displacement curves, and SSR ratios for SSR tests performed in both control and environmental test conditions, and method of measurement.

12.1.6 Examination of the specimen gauge section and fracture surface using appropriate analysis techniques to determine fracture mode and evidence of possible secondary cracking. Such means may include low-power microscopy, scanning electron microscopy, or metallographic sectioning. Photomicrographs of the fracture and surrounding areas should be included.

13. Keywords

13.1 corrosion testing; hydrogen embrittlement; liquid metal embrittlement; stress corrosion cracking; sulfide stress cracking; tension testing

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