Designation: B839 – 04 (Reapproved 2014)

Standard Test Method for Residual Embrittlement in Metallic Coated, Externally Threaded Articles, Fasteners, and Rod-Inclined Wedge Method[1]

This standard is issued under the fixed designation B839; 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.

INTRODUCTION

When atomic hydrogen enters steels and certain other alloys, it can cause loss of ductility or load carrying ability or cracking (usually as submicroscopic cracks), or catastrophic brittle failures at applied stresses well below the yield strength or even the normal design strength for the alloys. This phenomenon often occurs in alloys that show no significant loss in ductility, when measured by conventional tensile tests, and is frequently referred to as hydrogen-induced delayed brittle failure, hydrogen stress cracking, or hydrogen embrittlement. The hydrogen can be introduced during cleaning, pickling, phosphating, electroplating, autocatalytic processes, and in the service environment as a result of cathodic protection reactions or corrosion reactions. Hydrogen can also be introduced during fabrication, for example, during roll forming, machining, and drilling due to lubricant breakdown as well as during welding or brazing operations.

1. Scope

1.1 This test method covers the determination of, on a statistical basis, the probability of the existence of hydrogen embrittlement or degradation in:

1.1.1 A batch of barrel electroplated, autocatalytic plated, phosphated, or chemically processed threaded articles or fasteners and

1.1.2 A batch of rack plated threaded articles, fasteners, or rod.

1.2 Industrial practice for threaded articles, fasteners, and rod has evolved three graduated levels of test exposure to ensure reduced risk of hydrogen embrittlement (see Section 3). These levels have evolved from commercial applications having varying levels of criticality. In essence, they represent the confidence level that is required. They also represent the time that finished goods are held before they can be shipped and used. This time equates to additional cost to the manufacturer that may of necessity be added to the cost of the finished goods.

1.3 This test method is applicable to threaded articles, fasteners, and rod made from steel with ≥1000 MPa (with corresponding hardness values of 300 $HV_{10\ kgf}$, 303 HB, or 31 HR_c) or surface hardened threaded articles, fasteners, or rod.

1.4 This test method shall be carried out after hydrogen embrittlement relief heat treatment in accordance with the requirements of Guide B850. It may also be used for assessing differences in processing solutions, conditions, and techniques. This test method has two main functions: first, when used with a statistical sampling plan it can be used for lot acceptance or rejection, and second, it can be used as a control test to determine the effectiveness of the various processing steps including pre- and post-baking treatments to reduce the mobile hydrogen in the articles, fasteners, or rod. While this test method is capable of indicating those items that are embrittled to the extent defined in Section 3, it does not guarantee complete freedom from embrittlement.

1.5 This test method does not relieve the processor from imposing and monitoring suitable process control.

1.6 This test method has been coordinated with ISO/DIS 10587 and is technically equivalent. (**Warning—**Great care should be taken when applying this test method. The heads of embrittled articles, fasteners, or rod may suddenly break off and become flying projectiles capable of causing blindness or other serious injury. This hazard can occur as long as 200 h after the test has started. Hence, shields or other apparatus should be provided to avoid such injury.)

NOTE 1—Test Method F1940 can be used as a process control and

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verification to prevent hydrogen embrittlement in fasteners covered by this test method.

NOTE 2—The use of inhibitors in acid pickling baths does not necessarily guarantee avoidance of hydrogen embrittlement.

1.7 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings

B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings

F436 Specification for Hardened Steel Washers

B850 Guide for Post-Coating Treatments of Steel for Reducing the Risk of Hydrogen Embrittlement

F1940 Test Method for Process Control Verification to Prevent Hydrogen Embrittlement in Plated or Coated Fasteners

2.2 *ISO Standards:*

ISO/DIS 10587 Residual Embrittlement in Metallic Coated, Externally Threaded Articles, Fasteners and Rod—Inclined Wedge Method[3]

ISO 4519 Electrodeposited Metallic Coatings and Related Finishes—Sampling Procedures for Inspection by Attributes[4]

2.3 *Military Standard:*

MIL-STD-1312 Fastener Test Methods[4]

3. Terminology

3.1 *Definitions—*

3.1.1 For the purposes of this test method the following definitions apply:

3.1.2 *batch*—a distinct portion of items processed collectively as a single group through the same identical treatment steps at the same time on the same rack or in the same barrel.

3.1.3 *embrittled*—where parts fail immediately or up to 48 h in test.

3.1.3.1 *Discussion*—The degree to which parts within a single plated batch or a given lot can be embrittled can vary over a wide range. The degree of embrittlement is a function of the concentration of atomic hydrogen in the individual parts in the batch or lot, measured in parts per million, and in particular that portion of the hydrogen that is mobile or free to migrate to areas of high stress concentration.

3.1.4 *Grade 48 proof*—where there are no failures after 48 h of test.

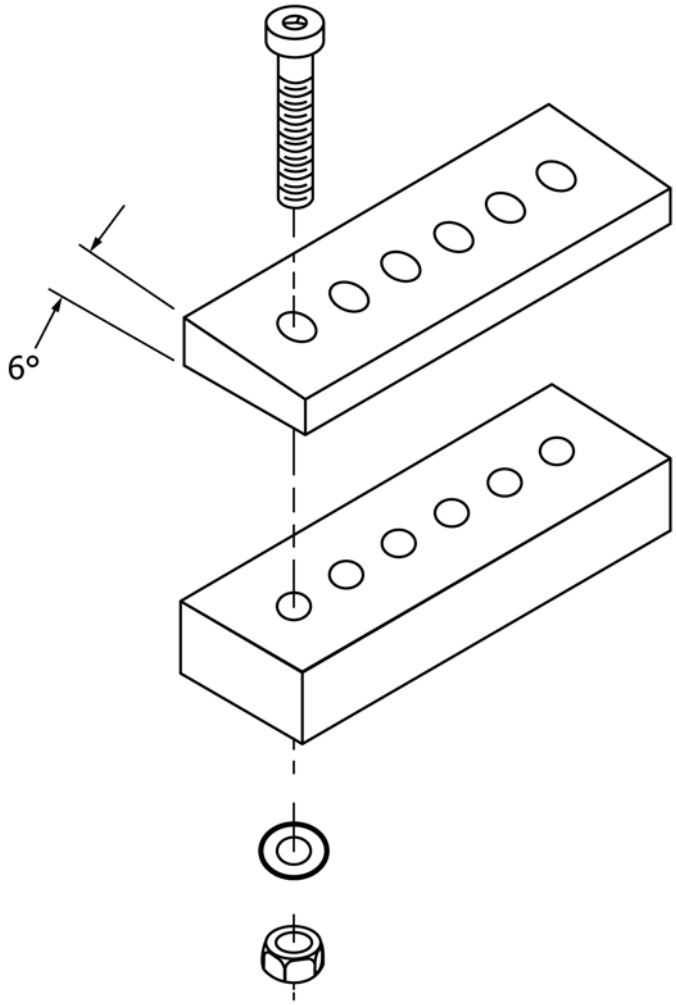

FIG. 1 Example of 6° Wedge and Parallel Filler Plate

3.1.5 *Grade 96 proof*—where there are no failures after 96 h of test.

3.1.6 *Grade 200 proof*—where there are no failures after 200 h of test.

3.1.7 *lot*—a group of items processed through the same or similar steps at the same time or over a contiguous time period and from the same heat of material. The lot may be broken down into a number of batches for processing purposes and then reassembled into the same lot.

4. Summary of Test Method

4.1 The threaded articles, fasteners, or rod are subjected to stress by tensioning with a mating nut after insertion through a clearance hole in a hardened rectangular wedge of steel; see Fig. 1. Additional hardened rectangular pieces of steel with parallel faces are provided as filler plates and are inserted so that the required length of the threaded article is placed under test. Other loading systems and fixtures are permissible as long as the same load, angle, and exposure are created for the test. The upper surface of the wedge is ground at an angle to the lower surface. The mating nut is tensioned by any means capable of measuring tensile load. The torque method described in 6.4 is one such method. If the torque method of

[2] 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.

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

[4] Available from Standardization Documents Order Desk, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.