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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Stress-Corrosion of Titanium Alloys by Aircraft Engine Cleaning Materials[1]

This standard is issued under the fixed designation F 945; 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

Chemical solutions and compounds used for preinspection cleaning or for preservation of titanium alloy aircraft turbine engine parts shall be subject to qualification requirements of this test method.

1. Scope

1.1 This test method establishes a test procedure for determining the propensity of aircraft turbine engine cleaning and maintenance materials for causing stress corrosion cracking of titanium alloy parts.

1.2 The evaluation is conducted on representative titanium alloys by determining the effect of contact with cleaning and maintenance materials on tendency of prestressed titanium alloys to crack when subsequently heated to elevated temperatures.

1.3 Test conditions are based upon manufacturer's maximum recommended operating solution concentration.

1.4 *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.* For specific precautionary statements, see 5.3 and 5.5.

2. Referenced Documents

2.1 *ASTM Standards:*
D 740 Specification for Methyl Ethyl Ketone[2]
D 841 Specification for Nitration Grade Toluene[2]
D 1193 Specification for Reagent Water[3]
2.2 *SAE Aerospace Material Specifications:*
AMS 4911 Sheet, Strip and Plate-6AL-4V Annealed[4]
AMS 4916 Sheet, Strip, and Plate-8AL 1MO 1V, Duplex Annealed[4]

3. Significance and Use

3.1 Because of the tendency of prestressed titanium alloy parts to crack if heated while in contact with certain chemical reagents, it is necessary to ensure that cleaning and maintenance materials will not initiate stress corrosion of titanium alloys under controlled conditions.

4. Apparatus

4.1 *Measuring Device* capable of linear measurement with a ±0.01-in. (±0.25-mm) tolerance.

4.2 *Press Forming Apparatus*[5] with 0.56-in. (14-mm) diameter mandrel capable of producing approximately 65° bends in 0.050-in. (1.25-mm) titanium alloy sheet specimens.

4.3 *Beakers or Small Tanks* for containment of cleaning, rinsing, and test solutions, appropriately lined to prevent contamination of the solutions by container materials.

4.4 *Vise*,[6] capable of precise manipulation at jaw opening of 0.65 in. (16.5 mm).

4.5 *Air Circulation Furnace*[7] capable of operating at 900°F (480°C) with control to ±20°F (10°C).

4.6 *Magnifier*[8] capable of 20-diameters magnification.

4.7 *Microscope*[9] capable of 500-diameters magnification.

4.8 *Bolt*, stainless steel, 0.25-in. (6-mm) diameter with stainless steel washers and nut.

4.9 *Test Specimens, AMS 4911 and AMS 4916 Titanium Alloys*—with specimens prepared from the same sheet stock for each alloy and cut parallel to the rolling direction to the dimensions of Fig. 1. The specimen edges shall not be deburred or otherwise relieved before testing.

4.10 *Cotton Gloves*, white.

5. Reagents and Materials

5.1 *Purity of Reagent*—Reagent grade chemicals shall be

[1] This test method is under the jurisdiction of ASTM Committee F-7 on Aerospace and Aircraft and is the direct responsibility of Subcommittee F07.07 on Qualification Testing of Aircraft Cleaning Materials.
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[2] *Annual Book of ASTM Standards*, Vol 06.04.
[3] *Annual Book of ASTM Standards*, Vol 11.01.
[4] Available from Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.
[5] A laboratory bench hydraulic press ENER PAC Model No. P-39 manufactured by Black Hawk Industrial Products, Butler, WI, has been found satisfactory.
[6] A standard sheet metal worker's vise with a 3-in. jaw has been found satisfactory.
[7] A Blue M Electric Co. POM-6680F-1 furnace has been found satisfactory.
[8] A Bausch and Lomb Stereo Zoom 4 Model KVB-73 has been found satisfactory.
[9] A Bausch and Lomb Micro Zoom Catalog No. 31-19-30-02 has been found satisfactory.

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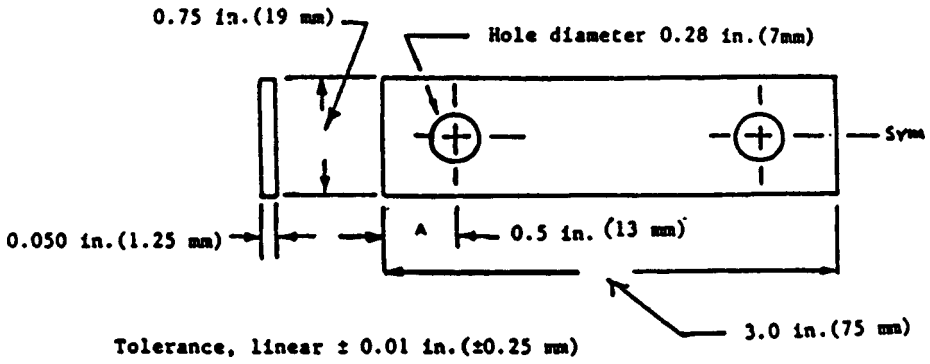

FIG. 1 U-Bend Specimen Dimensions

used in all cases. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[10] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of analysis.

5.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water conforming to Specification D 1193 Type IV.

5.3 *Cleaning Solution*, mix 35 volume % nitric acid (42 Be′) (**Caution**—See Annex A1.2) and 3 volume % hydrofluoric acid (70 %) (**Caution**—See Annex A1.3) with reagent water.

5.4 *Salt Solution*, dissolve 3 weight % sodium chloride in distilled water.

5.5 *Solvent*, toluene conforming to Specification D 841 or methyl ethyl ketone conforming to Specification D 740. (**Caution**—See Annex A1.1).

6. Precleaning Test Specimens

6.1 Handling contamination and shop soils may be removed by washing in a solvent. Dry thoroughly.

7. Specimen Fabrication

7.1 With the short specimen axis as the bend axis, press form the specimen around an approximately 0.45-in. (14-mm) diameter mandrel in one operation so that an unrestrained preform angle of approximately 65° is obtained. See Fig. 2.

7.2 Clean the specimen preform by immersing in cleaning solution of 5.3 for 15 ± 5 s. Rinse in clean water, then in reagent water. Air dry with the bend zone up. Use white cotton gloves when handling specimens and do not touch the bend zone after cleaning.

7.3 Final U-bend configuration shall be accomplished by bending the free ends of the preform together in a vise until the distance between the free ends is reduced to 0.65 in. ± 0.05 (16.5 ± 1 mm). See Fig. 3.

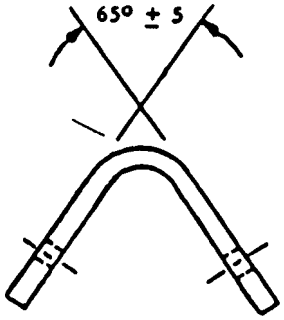

FIG. 2 Brake Formed U-Bend Specimen

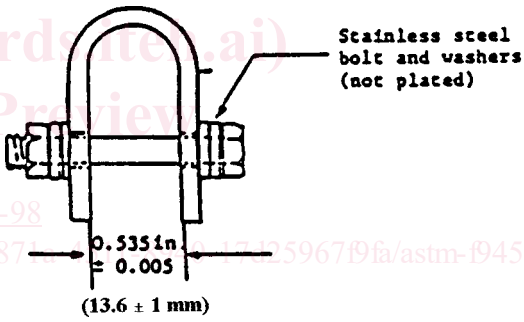

FIG. 3 Loaded U-Bend Specimen

7.4 Restrain the test specimen with sides approximately parallel by fastening the ends with a clean 0.25-in. (6-mm) diameter stainless steel bolt with washers. Unplated steel nuts may be used. See Fig. 1.

7.5 Load the specimen by tightening the bolt until the legs are 0.535 ± 0.005 in. (13.6 ± 0.10 mm) apart. See Fig. 3.

8. Procedure (See Fig. 4.)

8.1 Test a minimum of nine specimens of each alloy using the following procedure.

8.1.1 To establish acceptability of the titanium alloy sheet materials for use in these tests, test three restrained test specimens of each alloy without contacting any test solution after acid cleaning.

8.1.2 To establish sensitivity of the titanium alloy sheet materials to stress corrosion attack, wet three restrained test specimens of each alloy by immersing in a solution of 3 weight % of sodium chloride in reagent water. Hang to dry with the bend zone down. Remove and test as in 8.2.

8.1.3 To evaluate the effect of the candidate solution, wet

[10] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

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