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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE RECOMMENDED PRACTICE

ARP 1795A

Superseding AMS 1795

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CANCELLED

STRESS-CORROSION OF TITANIUM ALLOYS

Effect of Cleaning Agents on Aircraft Engine Materials

1. SCOPE:

1.1 This recommended practice 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 pre-stressed 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 Chemical solutions and compounds used for pre-inspection cleaning or for preservation of titanium alloy aircraft turbine engine parts shall be subject to qualification requirements of this test practice.

1.5 The test does not give consideration to cleaning or corrosion-preventive properties of the compounds.

2. APPLICABLE DOCUMENTS: The following publications form a part of this recommended practice to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 4911 - Titanium Alloy Sheet, Strip, and Plate, 6Al - 4V, Annealed
AMS 4916 - Titanium Alloy Sheet, Strip, and Plate, 8Al - 1Mo - 1V, Duplex Annealed

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3. PROCEDURE:

3.1 Panel Preparation: Test panels having dimensions as in Fig. 1 shall be cut parallel to the rolling direction from AMS 4911 and AMS 4916 titanium alloy sheet. Specimen edges shall not be deburred or otherwise relieved prior to testing.

3.2 Specimen Fabrication: With the short specimen axis as the bend axis, the specimen shall be press formed around a mandrel, nominally 0.56 in. (14.0 mm) in diameter, in one operation so that an unrestrained preform angle of approximately 65 deg is obtained (See Fig. 2). Specimen preform shall be cleaned by immersing for 15 sec ± 5 in an aqueous solution containing 35% by volume 69% nitric acid (42 Bé) and 3% by volume 70% hydrofluoric acid, rinsing in clean water, rinsing in distilled water, and air drying with the convex side of bend zone up. White cotton gloves shall be used when handling specimens and the bend zone shall not be touched after cleaning. 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 mm ± 1.2) (See Fig. 3). The test specimen shall then be restrained with sides approximately parallel by fastening the ends with a clean 1/4 in. (6 mm) diameter corrosion-resistant steel bolt with washers. Unplated steel nuts may be used (See Fig. 3). Load the specimen by tightening the bolt until the legs are 0.535 in. ± 0.005 (13.40 mm ± 0.12) apart (See Fig. 3).

3.3 Test Procedure: Not less than 9 specimens of each alloy, from the same sheet of alloy, shall be tested using the following procedures:

3.3.1 To establish acceptability of the titanium alloy sheet materials for use in these tests, three restrained test specimens of each alloy shall be tested without contact with any test solution after acid cleaning. Heating shall be in accordance with 3.3.4.

3.3.2 To establish sensitivity of the titanium alloy sheet materials to stress-corrosion attack, wet three restrained test specimens of each alloy in a solution of 3% by weight sodium chloride in distilled water, allow to dry with the convex side of bend zone down, and test as in 3.3.4.

3.3.3 To evaluate the effect of the candidate solution, carry out the manufacturer's recommended immersion process cycle on three restrained test specimens of each alloy at the maximum recommended concentration, allow to dry with the convex side of bend zone down, and test as in 3.3.4.

3.3.4 Heat restrained specimens in a circulating-air furnace in accordance with method(s) to be specified by purchaser as follows:

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3.3.4.1 Method A: Heat at 900°F ± 20 (480°C ± 10) for 8 hr ± 0.2.

3.3.4.2 Method B: Heat at 500°F ± 20 (260°C ± 10) for 168 hr ± 4.

3.3.4.3 After heating, specimens shall be removed from furnace, allowed to cool, and visually inspected for cracks using 20X magnification.

3.4 Preliminary Evaluation: Inspect all of the restrained specimens visually using 20X magnification.

3.4.1 If cracks are found on the untreated (control) specimens, the entire stress-corrosion test shall be repeated using acceptable titanium alloy sheet material.

3.4.2 If no cracks are found on any restrained specimen, remove bolts and rinse the specimens in warm water to remove soluble contaminants; while still wet, immerse in the nitric-hydrofluoric acid mixture of 3.2 for 15 sec ± 5, rinse, air dry, and inspect metallographically as in 3.5.

3.4.3 If cracks are found on the sodium-chloride solution treated specimens, but not on the candidate-solution treated specimens, clean the candidate-solution treated specimens and untreated (control) specimens as in 3.4.2 and examine metallographically as in 3.5.

3.4.4 If cracks are found on one, but not all, candidate-solution treated specimens of either titanium alloy, repeat the stress-corrosion test. If cracks are not found on any candidate-solution treated specimens, clean the candidate-solution treated and untreated (control) specimens as in 3.4.2 and examine metallographically as in 3.5.

3.5 Metallographic Inspection: A cross-section of each specimen shall be made at the bend normal to the bend axis (parallel to the test panel long axis). The cut shall be made approximately at the center axis in line with the holes. The metallographic specimen shall encompass material from the bend to a point approximately 1/2 in. (12.5 mm) from the bend. Examine the cut surface over the 1/2 in. (12.5 mm) distance on both sides of the bend zone at 500X magnification following appropriate metallographic preparation.

3.6 Metallographic Evaluation:

3.6.1 Detection of cracks on either the tension or compression surfaces of the untreated (control) specimens shall necessitate repeating the entire stress-corrosion test using acceptable titanium alloy sheet material.

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3.6.2 Failure to detect cracks on either the tension or compression surfaces of the sodium-chloride-solution treated specimens shall require repeating the entire stress-corrosion test using titanium alloy sheet having a demonstrated susceptibility to stress-corrosion cracking.

3.6.3 Detection of cracks on either the tension or compression surfaces of any of the candidate-solution treated specimens shall require repetition of the stress-corrosion test. Freedom from cracks on all candidate-solution treated specimens constitutes an acceptance test for the candidate material (provided the requirements of 3.6.1 and 3.6.2 have been met). Presence of cracks on all candidate-solution treated specimens shall be cause for rejection.

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This recommended practice is under the jurisdiction of AMS Committee "J" (AMCM).