SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4920C

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Superseding AMS 4920B

Titanium Alloy, Forgings
6Al - 4V
Alpha-Beta or Beta Processed, Annealed

(Composition similar to UNS R56400)

1. SCOPE:

1.1 Form:

This specification covers a titanium alloy in the form of forgings and forging stock.

1.2 Application:

These forgings have been used typically for parts that do not require heat treatment but require high mechanical properties in the annealed condition and for which processing above the beta transus is permissible, but usage is not limited to such applications. This alloy exhibits high strength-to-weight ratios up to 750 °F (399 °C).

1.2.1 Certain processing procedures and service conditions may cause these products to become subject to stress-corrosion cracking; ARP982 recommends practices to minimize such conditions.

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2249	Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS 2750	Pyrometry
AMS 2808	Identification, Forgings
ARP982	Minimizing Stress-Corrosion Cracking in Wrought Titanium Alloy Products

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM E 8 Tension Testing of Metallic Materials
ASTM E 8M Tension Testing of Metallic Materials (Metric)
ASTM E 120 Chemical Analysis of Titanium and Titanium Alloys
ASTM E 1409 Determination of Oxygen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique
ASTM E 1447 Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity Method

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the percentages by weight shown in Table 1; oxygen shall be determined in accordance with ASTM E 1409, hydrogen in accordance with ASTM E 1447, and other elements by wet chemical methods in accordance with ASTM E 120, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max
Aluminum	5.50	6.75
Vanadium	3.50	4.50
Iron	--	0.30
Oxygen	--	0.20
Carbon	--	0.10
Nitrogen	--	1.05 (500 ppm)
Hydrogen (3.1.1)	--	0.0125 (125 ppm)
Yttrium (3.1.3)	--	0.005 (50 ppm)
Residual Elements, each (3.1.2)	--	0.10
Residual Elements, total (3.1.2)	--	0.40
Titanium	remainder	

3.1.1 Hydrogen content of forgings may be as high as 0.0150 (150 ppm). When using ASTM E 1447, sample size may be as large as 0.35 gram.

3.1.2 Determination not required for routine acceptance.

3.1.3 Check Analysis: Composition variations shall meet the requirements of AMS 2249. No variation over maximum will be permitted for yttrium.

3.2 Melting Practice:

3.2.1 Alloy shall be multiple melted. Melting cycle(s) prior to the final melting cycle shall be made using consumable electrode, nonconsumable electrode, electron beam, or plasma arc melting practice(s). The final melting cycle shall be made under vacuum using consumable electrode practice with no alloy addition permitted.

3.2.1.1 The atmosphere for nonconsumable electrode melting shall be vacuum or shall be argon and/or helium at an absolute pressure not higher than 1000 mm of mercury.

3.2.1.2 The electrode tip for nonconsumable electrode melting shall be water-cooled copper.

3.3 Condition:

The product shall be supplied in the following condition:

3.3.1 Forgings: Annealed and descaled.

3.3.2 Forging Stock: As ordered by the forging manufacturer.

3.4 Annealing:

Forgings shall be annealed by heating to a temperature within the range 1300 to 1400 °F (704 to 760 °C), holding at the selected temperature within ±25 °F (±14 °C) for a time commensurate with section thickness and the heating equipment and procedure used, and cooling at a rate which will produce forgings meeting the requirements of 3.5.1. Pyrometry shall be in accordance with AMS 2750.

3.5 Properties:

The product shall conform to the following requirements:

3.5.1 Forgings:

3.5.1.1 Tensile Properties: Forgings, 6.000 inches (152.40 mm) and under in cross-sectional thickness, shall have the properties shown in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M on specimens as in 4.3.1.2 with the rate of strain maintained at 0.003 to 0.007 inch/inch/minute (0.003 to 0.007 mm/mm/minute) through the yield strength and then increased so as to produce failure in approximately one additional minute. When a dispute occurs between purchaser and vendor over the yield strength values, a referee test shall be performed on a machine having a strain rate pacer, using a rate of 0.005 inch/inch/minute (0.005 mm/mm/minute) through the yield strength and a minimum cross head speed of 0.10 inch per minute (0.04 mm/second) above the yield strength.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	130 ksi (896 MPa)
Yield Strength at 0.2% Offset	120 ksi (827 MPa)
Elongation in 4D	8%
Reduction of Area	15%

3.5.1.2 Surface Contamination: Except as permitted by 3.5.1.2.1, forgings shall be free of any oxygen-rich layer (See 8.2), such as alpha case, or other surface contamination, determined by microscopic examination at not lower than 400X magnification or by other method acceptable to purchaser.

3.5.1.2.1 When permitted by purchaser, forgings to be machined all over may have an oxygen-rich layer provided such layer is removable within the machining allowance on the forging.

3.5.1.3 Microstructure: Shall be that structure resulting from alpha-beta or beta processing, as specified by purchaser (See 8.6). When no structure is specified, alpha-beta processing shall be performed. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5.2 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 3.4, specimens taken from the heat treated coupon shall conform to the requirements of 3.5.1.1. If specimens taken from the stock after heat treatment as in 3.4 conform to the requirements of 3.5.1.1, the tests shall be accepted as equivalent to tests of a forged coupon.

3.6 Quality:

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.6.1 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of re-entrant grain flow.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of the product shall supply all samples for vendors tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: The following requirements are acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (3.1) of each heat.

4.2.1.2 Hydrogen content (3.1), tensile properties (3.5.1.1), surface contamination (3.5.1.2), and microstructure (3.5.1.3) of each lot of forgings.

4.2.2 Periodic Tests: Tests for ability of forging stock to develop required properties (3.5.2) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

Shall be in accordance with the following; a lot shall be all product of the same part number from the same heat, processed at the same time, and annealed in the same heat treat batch.

4.3.1 For Acceptance Tests:

4.3.1.1 Composition: One sample from each heat, except for hydrogen determinations one sample from each lot obtained after thermal and chemical processing has been completed.

4.3.1.2 Tensile Properties: One or more specimens from each lot of forgings. The location and orientation of the specimen, and the number of any additional specimens, shall be as agreed upon between purchaser and vendor.

4.3.1.3 Surface Contamination and Microstructure: One or more samples from each lot.

4.4 Reports:

4.4.1 The vendor of forgings shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and for the hydrogen content and tensile properties of each lot, and stating that the forgings conform to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS 4920C, specific annealing treatment used, quantity, part number, and the size and melt source of stock used to make the forgings.

4.4.2 The vendor of forging stock shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and for the hydrogen content of each lot. This report shall include the purchase order number, heat number, AMS 4920C, size, and quantity.