SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2757B

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Superseding AMS 2757A

Gaseous Nitrocarburizing

1. SCOPE:

1.1 Purpose:

This specification covers the engineering requirements for producing a continuous thin epsilon-iron-carbonitride compound layer on parts by means of a gaseous, low temperature process, and properties of the case.

1.2 Application:

This process has been used typically to increase wear resistance and fatigue and to improve corrosion resistance on ferrous metals, such as carbon, low-alloy, and tool steels, and cast irons, but usage is not limited to such applications. This process can be selectively applied to wear areas of the component.

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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
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Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.1 SAE Publications:

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

AMS 2408	Plating, Tin
AMS 2418	Plating, Copper
AMS 2429	Masking, Bronze Plate, Nitriding Stop-Off, 90Cu - 10Sn
AMS 2750	Pyrometry
AMS 2759	Heat Treatment of Steel Parts, General Requirements
ARP1820	Chord Method of Evaluating Surface Microstructural Characteristics
SAE J423	Methods of Measuring Case Depth
SAE J864	Surface Hardness Testing With Files

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM E 384	Microhardness of Materials

2.3 ASM Publications:

Available from ASM International, 9639 Kinsman Road, Materials Park, OH 44073-0002 or www.asm-intl.org.

ASM Handbook, 9th Edition, Metallography and Microstructure

3. TECHNICAL REQUIREMENTS:

3.1 Processing Equipment:

Parts to be nitrocarburized shall be processed in an integral quench, sealed retort, fluidized bed, or atmosphere-type furnace conforming to AMS 2759. Furnace temperature uniformity requirements shall be ±15 °F (±8 °C).

3.1.1 Atmosphere: The nitrocarburizing atmosphere shall consist of a mixture of ammonia and a carrier gas. Acceptable carrier gases are: endothermic, refined exothermic gas, and high purity nitrogen; a hydrocarbon gas and/or oxygen-bearing gas additions may be used for enrichment.

3.1.2 Furnace Controls: Shall conform to AMS 2750.

3.1.3 Thermocouples: When load thermocouples are required, they shall be sheath-protected to prevent deterioration due to furnace atmospheres.

3.2 Pretreatment:

3.2.1 Hardening: Parts, where core hardening is specified, shall be heat treated in accordance with AMS 2759 or as specified by the cognizant engineering organization to the required core hardness prior to gaseous nitrocarburizing. Tempering for the specified core hardness shall be at a temperature not less than 50 °F (28 °C) degrees above the nitrocarburizing temperature.

3.2.2 Surface Condition: Parts shall be clean and free of scale, oxide, entrapped sand, mold or core sand material, metal particles, oil, or grease prior to the nitrocarburizing process. Parts must be dry.

3.2.3 Stress Relief: Parts, which have been machined or straightened before nitrocarburizing, may be stress relieved in accordance with AMS 2759 prior to nitrocarburizing. Stress relieving shall be done at a temperature not less than 20 °F (11 °C) degrees above the highest nitrocarburizing temperature to be used. Surfaces to be nitrocarburized shall be mechanically or chemically cleaned subsequent to stress relieving and prior to nitrocarburizing.

3.2.4 Selective Nitrocarburizing (Masking): If parts are not to be nitrocarburized all over, such surfaces shall be masked. Masking may be accomplished by copper plating in accordance with AMS 2418, bronze plating in accordance with AMS 2429, or tin plating in accordance with AMS 2408. Alternatively, parts may be nitrocarburized all over and the case machined off surfaces not to be nitrocarburized. Other maskants, such as stop-off paints, may be used if approved by the cognizant engineering organization.

3.3 Procedure:

3.3.1 Fixturing: Parts shall be racked and supported to prevent distortion at temperature and to ensure free atmosphere circulation and reaction with all surfaces during the nitrocarburizing process. Trays and fixtures shall not affect the temperature uniformity or gas circulation in the processing unit.

3.3.2 Cycle Times: Processing cycles are shown in Table 1.

TABLE 1 - Processing Cycles

Material	Process Temperature Range °F	Process Temperature Range °C	Process Time Range Hours
Carbon Steel	1060 to 1200	571 to 649	1 to 3
Low-Alloy Steel	1060 to 1160	571 to 627	1 to 3
Tool Steel, Structural	1000 to 1060	538 to 571	0.5 to 3
Tool Steel, Cutting	1000 to 1025	538 to 552	0.1 to 2
Cast Iron (Ductile, Gray, and Malleable)	1060 to 1200	571 to 649	1 to 6

3.3.2.1 Preheating: Parts may be preheated in air to a temperature not higher than 850 °F (454 °C).

3.3.3 Quenching: Following treatment, parts may be quenched in oil, water, soluble oil solutions, aqueous polymer quenchants, inert or nitrocarburizing atmospheres, or air (See 8.2).

3.4 Properties:

Gaseous nitrocarburized parts shall conform to the following requirements, determined on parts or on test specimens as in 4.3.1.

3.4.1 Depth of Compound Layers: Shall be as shown in Table 2, determined in accordance with the procedure of SAE J423 or ARP1820 microscopic methods, at not less than 500X magnification.

TABLE 2 - Compound Layer Thickness

Material	Thickness Inch, min	Thickness Inch, max	Thickness mm, min	Thickness mm, max
Carbon Steel	0.00015	0.0010	0.0038	0.025
Low-Alloy Steel	0.00015	0.0010	0.0038	0.025
Tool Steel, Structural	0.0001	0.0005	0.0025	0.013
Tool Steel, Cutting	--	0.0002	--	0.005
Cast Iron	0.00015	0.0010	0.0038	0.025

3.4.2 Presence of Compound Layer: Presence of a compound layer on non-austenitic steels and cast irons shall be confirmed by means of a chemical spot test. A drop of copper ammonium chloride (3.4.2.1) or copper sulfate solution (3.4.2.2) applied to a clean nitrocarburized surface of a part shall turn a reddish-brown color after 15 seconds. If copper plates out on the surface after this procedure, the compound layer is not present and the part is subject to rejection.

3.4.2.1 Copper Ammonium Chloride Solution: Dissolve 100 grams cupric chloride ($CuCl_2 \bullet 2H_20$) in distilled water to make one liter. Add ammonium hydroxide to form a copper ammonium chloride complex.

3.4.2.2 Copper Sulfate Solution: Dissolve 40 grams copper sulfate ($CuSO_4 \bullet 5H_20$) in 1000 mL distilled water and 5 mL wetting agent (i.e., glycerin); pH shall be 3.5 to 4.1.

3.4.3 Compound Layer Structure: Not less than three fields shall be examined at 500X magnification employing acceptable quantitative metallographic procedures of line intercept or grid analysis (as described in ASM Handbook, 9th Edition, Metallography and Microstructure, pages 123 to 134). The upper half of the total compound-thickness, as in 3.4.2, shall not contain more than 30% residual porosity and oxides in any one field viewed. The compound layer at the substrate interface and the lower quarter of the total compound thickness shall not exhibit residual porosity and oxides exceeding 5% for steel and corrosion-resistant steel components and 15% for cast iron components.

3.4.4 Compound Layer Hardness: The layer hardness should be equivalent of 60 HRC or greater, determined in accordance with SAE J864 for file hardness. Light load microhardness testing of the surface can be done and will be specified in accordance with component design criteria by the cognizant engineering organization.

3.4.5 Diffusion Zone Hardness (Case): Shall be as shown in Table 3, determined by microhardness measurements at a depth of 0.002 inch (0.05 mm) from the treated surface in accordance with ASTM E 384 or by the chordal method of ARP1820 on prepared cross sections of the nitrocarburized case using Knoop or other appropriate hardness tester, as agreed upon by the cognizant engineering organization.

TABLE 3 - Diffusion Zone Minimum Hardness

Material	Hardness HK100
Carbon Steels	300
Low Alloy Steels	460
Tool and Die Steels, Structural	600
Tool and Die Steels, Cutting	700
Cast Iron (Gray, Ductile, or Malleable)	300

3.5 Logs:

A record (written or electronic storage media), traceable to temperature recording information (chart(s) or electronic storage media) and to shop travelers or other documentation, shall be kept for each furnace and load. The information on the combination of documents shall include: equipment identification, approved personnel's identification, date; part number or product identification, number of parts, alloy, lot identification, AMS 2757 or other applicable specification, actual thermal processing times and temperatures used. When applicable, atmosphere control parameters, quench delay, quenchant type, polymer concentration and quenchant temperature shall also be recorded. The maximum thickness, when process parameters are based on thickness, shall be recorded and shall be taken as the minimum dimension of the heaviest section of the part. The log data shall be recorded in accordance with the heat treater's documented procedures.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

Purchaser of treated parts shall supply all necessary test coupons; the processor 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 parts conform to specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Depth of compound layer (3.4.1), presence of compound layer (3.4.2), and compound layer hardness (3.4.4) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Compound layer structure (3.4.3) and diffusion zone hardness (3.4.5) are periodic tests and shall be performed at a frequency selected by the processor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: All technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of a part to a purchaser, when a change in material and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing:

Sufficient parts or test coupons of the same alloy, surface condition, and pretreatment as the parts represented, shall be processed with each furnace load to permit duplicate conformation tests for each acceptance requirement (4.2.1). A lot shall be all parts of the same part number processed in the same furnace load. The number of parts or coupons for testing shall be established by purchaser.

4.4 Approval:

4.4.1 Sample parts shall be approved by purchaser before parts for production use are supplied, unless such approval be waived by purchaser.

4.4.2 Processor shall use manufacturing procedures, processes, and methods of inspection on production parts which are essentially the same as those used on approved sample parts. If necessary to make any change in established limits of the case or nitrocarburizing procedures, processor shall submit for reapproval a statement of the revised operations and, when requested, sample nitrocarburized parts or test coupons. Production parts nitrocarburized by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Report/Certification

The heat treating processor shall furnish, with each shipment of parts, a certified quality assurance report, traceable to the heat treat control number(s), stating that the parts were processed in accordance with the requirements of AMS 2757B (or other applicable specification). The report shall include: purchase order number, part number or product identification, alloy, temper/strength designation, quantity of parts in the shipment, identification of furnace(s) used, actual thermal processing times and temperatures used. When applicable, the report shall also include: atmosphere type, quenchant (including polymer concentration range), hot straightening temperature and method of straightening (e.g. press, fixtures), actual test results, (e.g., hardness, conductivity, tensile, shear etc.) and a statement of their conformance/nonconformance to requirements. This data shall be reported in accordance with the heat treater's documented procedures.