



AEROSPACE MATERIAL SPECIFICATION

AMS2678™**REV. A**

Issued 2006-08
Revised 2013-02
Reaffirmed 2019-01

Superseding AMS2678

Furnace Brazing of Parts in a Vacuum Atmosphere

RATIONALE

AMS2678A includes changes to 3.2 to list acceptable gases for partial pressure atmosphere, and changes to 3.5.2 and 3.5.2.2 detailing requirements for load thermocouples.

1. SCOPE

1.1 Purpose

This specification covers the requirements and procedures for the brazing of parts in a very low pressure gas which referred to as "vacuum" herein.

1.2 Application

This process provides general requirements and practices for vacuum brazing carbon and alloy steels, corrosion resistant steels, precipitation hardening alloys, nickel and cobalt-based alloys, aluminum alloys, and titanium alloys, but usage is not limited to such applications. For specific brazing requirements for the materials to be brazed, the applicable AMS, AWS, or other engineering specification should be referenced.

1.2.1 When there is a conflict between the requirements of this braze specification and the applicable specific brazing specification, requirements of the specific brazing specification shall take precedence.

1.3 Safety - Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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.

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Documents
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2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2750 Pyrometry

AMS2769 Heat Treatment of Parts in a Vacuum

ARP1962 Training and Approval of Heat-Treating Personnel

2.2 NFPA Publications

Available from National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471 or www.nfpa.org.

NFPA 86 Standard for Ovens and Furnaces

3. TECHNICAL REQUIREMENTS

3.1 Furnace Equipment

The furnace components shall not deleteriously affect material processed during a normal production run. Material may be affected, for example, by physical or chemical reaction between the parts and the furnace components or gases used to maintain partial pressure in the furnace. See also 3.5.3.1.

3.1.1 Vacuum System

The vacuum pumping system shall have sufficient pumping capacity to evacuate the furnace to a pressure within the recommended range for the materials being processed, and to maintain the required pressure during the entire brazing process, including any periods when a partial pressure is maintained using a controlled flow of gas. See also 3.2.

3.1.1.1 Vacuum Sensing Equipment

The vacuum furnace shall be equipped with at least one gauge capable of sensing and recording the pressure in the vacuum heating chamber of the furnace. Vacuum sensing equipment shall be calibrated in accordance with the manufacturer's specification. Gauge types in Table 1 are recommended for the pressure ranges shown.

TABLE 1 - PRESSURE VERSUS RECOMMENDED GAUGE TYPE

Pressure (Microns)	Gauge
1 to 10^3	Thermocouple or Pirani
10^{-6} to 1	Hot filament ionization
10^{-4} to 10	Cold cathode ionization

3.1.1.2 Vacuum Gauge Calibration

The method of vacuum gauge calibration shall be in accordance with the manufacturer's specification and shall be acceptable to the purchaser. For furnaces used for processing materials at pressures of 1 micron or lower, vacuum gauges shall be calibrated every 3 months; otherwise, vacuum gauges shall be calibrated at least annually, unless conditions necessitate more frequent calibrations. Alternatively, a frequency may be established by periodic testing and agreed to by the purchaser.

3.1.1.3 Leak Rate

Testing for gas leakage shall be performed at ambient or elevated temperature. Initial leak rate shall be determined after closing the vessel and evacuating to at least 50 microns. After reaching the initial evacuation level set point for the process being performed, all valves to the vessel chamber shall be closed, the initial pressure recorded, and a second reading of pressure made a minimum of 15 minutes after the first reading. Leak rate shall then be determined by dividing the rise in pressure (difference between final and initial readings) by the time in hours. Leak rate shall be expressed as microns per hour. Permissible leak rate shall be in accordance with AMS2769 or as specified by the purchaser.

3.1.1.4 If the leak rate test fails, the furnace may be baked out as specified in 3.1.1.5 and retested.

3.1.1.5 Bake-Out Cycle

The furnace shall be subjected to a bake-out (clean up) cycle monthly or when one or more of the following conditions occurs:

The furnace fails a periodic leak rate test as in 3.1.1.3.

After cycles where aluminum brazing filler metals are used and other filler metal brazing cycles are to follow.

Before running titanium base metals or filler metals containing titanium.

3.1.1.5.1 The bake-out cycle shall be performed at a minimum of 50 °F (28 °C) above the brazing temperature to be used on the next series of brazing cycles.

3.1.1.5.2 Bake-out shall be for a period of 1 hour minimum at the lowest achievable furnace pressure, and until the pressure is within the brazing range specified by the cognizant engineering organization or no change in pressure is observed over a period of 30 minutes.

3.1.1.5.3 Following the bake-out period, the furnace shall be cooled to a temperature lower than the brazing temperature, and the leak rate measured using the method in 3.1.1.3.

3.1.2 Pyrometry shall conform to AMS2750.

3.1.2.1 Thermocouples

Thermocouple types K, N, and Nickel-Nickel Molybdenum shall be suitably protected by enclosing them in metal or ceramic sheaths, and shall be of a type compatible with the range of temperatures and vacuum conditions used. They shall be of a suitable size and located in such a way that the sheaths receive direct radiation from the heating elements and furnace walls.

3.1.2.1.1 The thermocouple types shown in Table 2 shall be used in vacuum for furnace control or temperature uniformity test measurements unless otherwise approved by the cognizant engineering organization.