SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS3025 | REV. C

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Superseding AMS3025B

Polyalkylene Glycol Heat Treat Quenchant

RATIONALE

AMS3025C results from a Five Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers two types of polyalkylene glycol in the form of a liquid.

1.2 Application

This product has been used typically as a quenching medium for solution heat treatment of aluminum alloys to minimize distortion and reduce residual stresses.

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 sole 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.

1.4 Classification

Quenchants covered by this specification are classified as:

Type 1 Single Polymer
Type 2 Multiple Polymer

1.4.1 The type supplied shall be as specified on the purchase order.

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)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS3025C

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.

AMS2770 Heat Treatment of Wrought Aluminum Alloy Parts
AMS2772 Heat Treatment of Aluminum Alloy Raw Materials
AMS2825 Material Safety Data Sheets

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B 557 Tension Testing Wrought and Cast Aluminum and Magnesium Alloy Products
ASTM B 557M Tension Testing Wrought and Cast Aluminum and Magnesium Alloy Products (Metric)
ASTM D 445 Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)
ASTM D 1218 Refractive Index and Refractive Dispersion of Hydrocarbon Liquids
ASTM D 1298 Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
ASTM D 4057 Manual Sampling of Petroleum and Petroleum Products
ASTM D 6482 Determination of Cooling Characteristics of Aqueous Polymer Quenchants by Cooling Curve Analysis with Agitation (Tensi Method).
ASTM D 6549 Determination of Cooling Characteristics of Aqueous Polymer Quenchants by Cooling Curve Analysis with Agitation (Drayton Unit).
ASTM D 6666 Evaluation of Aqueous Polymer Quenchants.
ASTM E 203 Water Using Karl Fischer Reagent

2.3 ANSI Publications

Available from American National Standards Institute 25 West 43rd Street, New York, NY 10036, Tel: 212-642-4900, www.ansi.org.

ANSI B46.1 Surface Texture

3. TECHNICAL REQUIREMENTS

3.1 Material

Shall be polyalkylene glycol and shall meet the requirements of 3.2 and 3.3.

3.2 Properties

Quenchant shall conform to the following requirements; tests shall be performed in accordance with specified test methods on quenchant supplied both in concentrated form and at the dilution specified in Table 1.

TABLE 1 - PROPERTIES

Paragraph	Test	Value	Test Method
3.2.1	Condition As-received in concentrated form:		
3.2.1.1	Water Content (Chemically Combined, By Weight)		ASTM E 203
	Type 1	45 - 48%	
	Type 2	57 - 63%	
3.2.1.2	Specific Gravity		ASTM D 1298
	Type 1	1.094 ± 0.005	
	Type 2	1.080 ± 0.025	
3.2.1.3	Refractive Index at 68 °F (20 °C)		ASTM D 1218
	Type 1	1.4140 ± 0.0050	
	Type 2	1.3910 ± 0.0050	
3.2.1.4	Viscosity at 100 °F (38 °C)		ASTM D 445
	Type 1	535 cSt ± 70	
	Type 2	300 cSt ± 20	
3.2.2	Conditioned; Diluted to 20% ± 0.50 by Volume, with Water		
3.2.2.1	Viscosity at 100 °F (38 °C)		4.5.1
	Type 1	5.5 cSt ± 0.5	
	Type 2	4.4 cSt ± 0.5	
3.2.2.2	Separation Temperature		4.5.2
	Type 1	165 °F ± 5 (74 °C ± 3)	
	Type 2	165 °F ± 5 (74 °C ± 3)	

3.3 Quenching Capability

The minimum tests for qualification shall be those specified in Table 2.

TABLE 2 - REQUIRED PREPRODUCTION TESTS

Panel Alloy	Panel Form	Panel Dimensions (1) Inches (mm)	Panel Final Temper	Cooling Rate	Tensile & Yield Strength	Intergranular Corrosion Resistance
2024	Bare Sheet	0.063 × 1 × 3 (1.60 × 25 × 76)	T42	-	-	Yes
7075	Bare Sheet	0.063 × 1 × 3 (1.60 × 25 × 76)	W	Yes	-	-
7075	Plate	0.250 × 6 × 9 (6.35 × 152 × 229)	T62	Yes	Yes	-
7075	Forging(2)	1.000 × 5 × 4 (25.40 × 127 × 102)	T6	Yes	Yes	-
7075	Forging(2)	2.000 × 8 × 7 (50.80 × 203 × 178)	T73	-	Yes	-

NOTES:
(1) Width and length dimensions are minimums and apply to tensile tests only. Width and length dimensions for cooling rate panels shall be four times the thickness. Tolerance on width and length are ±1/8 inch (±3.2 mm). Tolerances on thickness of sheet and plate shall be as specified in AMS2202.
(2) Plate may be used to simulate forgings. (See 4.5.4.1)

3.3.1 Cooling Rates

The cooling rates from 750 to 550 °F (399 to 288 °C), measured in accordance with 4.5.3, shall be specified in Table 3.

TABLE 3 - COOLING RATE

Nominal Thickness Inch	Nominal Thickness Millimeters	Cooling Rate Degrees/Second °F	Cooling Rate Degrees/Second °C
0.063	1.60	900 to 1800	482 to 982
0.250	6.35	240 to 360	116 to 182
1.000	25.40	50 to 75	10 to 24

3.3.2 Tensile Strength

The longitudinal tensile and yield strengths of panels heat treated with a glycol quench shall be equivalent to those of identical panels quenched in water, determined in accordance with 4.5.4.

3.3.2.1 The strengths shall be judged equivalent if the average of all results from glycol-quenched panels is within 2000 psi (13.8 MPa) of those of water-quenched panels, providing that the averages for a single test lot do not differ by more than 3000 psi (20.7 MPa).

3.3.3 Intergranular Corrosion Resistance

Panels of 2024 aluminum alloy from Table 2, solution heat treated with a glycol quench, shall not be more severe than that of identical panels quenched in water, determined in accordance with 4.5.5.

3.4 Quality

The quenchant shall be homogeneous and free from contamination. The constituents in the quenchant shall not adversely affect its use as a low-distortion quenchant or the alloy being quenched.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of the quenchant shall supply all samples for vendor's 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 quenchant conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Preproduction Tests

All technical requirements are preproduction tests.

4.2.2 Acceptance Tests

Water content (3.2.1.1), specific gravity (3.2.1.2), and refractive index (3.3.1.3) as-received, and for viscosity (3.2.2.1) and separation temperature (3.2.2.2) of a 20% dilution are acceptance tests and shall be performed on each lot.

4.3 Requirements for Testing

4.3.1 Preproduction tests shall be conducted by the vendor on the quenchant to qualify the quenchant to this specification prior to the first production lot. These tests shall be performed prior to or on the initial shipment of quenchant to a purchaser, when a change in ingredients and/or processing requires reapproval as in 4.3.1.1, and when a purchaser deems confirmatory testing to be required.

4.3.1.1 New preproduction tests shall be required if the vendor finds it necessary to make any change in polymer type or polymer molecular weight, in type of equipment for processing, or in manufacturing procedures. Changes in rust inhibitor packages to satisfy environmental regulations (Federal, State or Local), do not require new preproduction tests, as long as the quenching characteristics are not changed, as measured by cooling curve measurements performed on a 1-inch aluminum panel as required in 4.5.3 and meet the requirements of Table 3.

4.3.1.2 Material qualified to previous revisions of this specification shall not require requalification, unless purchaser deems confirmatory testing will be required.

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4.4 Sampling and Testing

Shall be in accordance with ASTM D 4057; a lot shall be one batch or tank of quenchant offered for delivery at one time. A lot shall not exceed 10 000 gallons (37 854 L).

4.4.1 Test Methods

4.4.1.1 Viscosity

The as-received quenchant shall be diluted to a concentration of 20% + 0.5 by volume of quenchant, using distilled or deionized water. When diluting to 20% by volume with water, the initial water content (chemically combined with glycol) shall not be considered as a part of the water of dilution. The viscosity of the diluted sample shall be determined at 100 °F ± 1 (38 °C ± 0.6) in accordance with ASTM D 445.

4.4.1.2 Separation Temperature

Shall be determined by the following procedure:

4.4.1.2.1 Heat not less than a 250 mL portion of a well-mixed representative sample of diluted quenchant in a 25 × 150 mm Pyrex test tube.

4.4.1.2.2 Fit a cork stopper with a 0 to 212 °F (18 to +100 °C) thermometer so that the thermometer bulb is completely immersed in the liquid. The cork stopper should fit snugly in the test tube but should have a small V-notch on one side to vent the vapor space in the test tube.

4.4.1.2.3 Immerse the test tube in a suitable heating bath (water or clear oil) so that the liquid in the test tube is below the bath surface. Keep the test tube away from the sides and bottom of the heating bath.

4.4.1.2.4 Heat the bath slowly (about 5 F (3 C) degrees/minute) with a suitable heater and closely observe the sample in the test tube. Continue heating (but higher than 175 °F (79 °C)) until the sample becomes hazy.

4.4.1.2.5 When the sample exhibits some haze, immediately remove the test tube from the bath long enough to swirl the contents. The haze should disappear. Return the test tube to the bath and repeat this procedure until a permanent haze persists throughout the sample. Immediately observe the sample temperature.

4.4.1.2.6 Cool the sample slightly with agitation until the solution is again clear. Re-immerse in the heating bath and repeat the previous step until the haze persists again. Re-observe the sample temperature and average with the first temperature observation.

4.4.1.2.7 The two readings should differ by no more than 2 °F (1 °C). If the readings differ by more than 2 °F (1 °C), repeat the entire process with three test temperature observations until all three observations are within 2 °F (1 °C).

4.4.2 Cooling Rates

Shall be determined by quenching the panels specified in Table 2.

4.4.2.1 For the 0.250 inch (6.35 mm) and 1.0 inch (25 mm) thick panels, an electrically insulated chrome-lalumel thermocouple, not larger than 24 gauge (0.533 mm), shall be inserted in a blind hole to the mid-thickness ±0.020 inch (±0.51 mm) at the geometric center. The thermocouple shall be inserted in a manner that ensures intimate contact with the panel for optimum thermal transfer and shall be sealed to prevent intrusion of moisture and quenchant. Before each test, thermocouple contact with the part shall be verified with electrical resistance tests. A second thermocouple of the same size shall be positioned on the outside surface to determine the instant the specimen enters the quenchant. Panels shall have a surface finish of 32 to 63 microinches (0.8 to 1.6 µm) Ra determined in accordance with ANSI B-46.1 and shall be chemically deoxidized prior to heating.

4.4.2.2 The 0.063 inch (1.60 mm) thick panel shall only have a thermocouple attached to the surface at the center.

4.4.2.3 The panels shall be soaked at the solution heat treating temperature specified in AMS2770 and quenched in the glycol/water solution maintained at 85 to 90 °F (29 to 32 °C). The glycol concentration used shall be the maximum specified in AMS2770 for the alloy/form/thickness. The tolerance on the glycol concentration shall be +0, 1%. The quench tank shall have no agitation.

4.4.2.4 The time/temperature cooling curve shall be recorded using a high speed oscillographic recorder or a computer based data acquisition system. The temperature recording instrument shall be calibrated prior to testing using a temperature source traceable to National Institute of Standards and Technology (NIST) standards. The quench delay shall be recorded. The cooling rate between 750 and 550 °F (399 and 288 °C) shall be calculated. Duplicate tests shall be run on separate panels.

4.4.3 Tensile Properties

Ultimate tensile and yield strengths shall be determined in accordance with ASTM B 557 or ASTM B 557M on two identical groups of panels; each group shall contain panels from two different lots of metal from each of two different producers. All tensile tests to be compared shall be performed on the same machine by the same operator.

4.4.3.1 Solution Heat Treatment

Shall conform to AMS2770. One group of panels shall be quenched in glycol and the other in water. The glycol concentration used shall be the maximum specified in AMS2770 for the alloy/form/thickness. The tolerance on the glycol concentration shall be +0, 1%. Quenchant temperatures shall be 85 to 90 °F (29 to 32 °C) except water used for quenching forgings (or plate if used to simulate forgings) shall be 155 to 160 °F (68 to 71 °C). The quenchant temperature shall not rise more than 10 °F (6 °C) during quenching. For the tensile property test, the quenchant shall be agitated sufficiently during quenching to ensure that fresh quenchant is in constant contact with the surface of the hot metal during the entire quench. The agitation shall be identical for both groups.

4.4.3.2 Precipitation Heat Treatment

The two groups being compared shall be given identical aging at room temperature. For convenience, room temperature aging may be arrested by refrigerating at -10°F (-23 °C) or below. The two groups shall be precipitation heat treated at elevated temperature in accordance with AMS2770 in the same load in the same location within the limitations of good racking practice.

4.4.3.3 Testing

One longitudinal tensile specimen shall be cut from each side of the center line of each panel. The tensile specimens made from sheet and plate panels 0.250 inch (6.35 mm) and under in nominal thickness shall be flat and of full thickness. Those made from panels over 0.250 inch (6.35 mm) in nominal thickness shall be round with 0.250 inch (6.35 mm) diameter reduced section and the axis of the specimen shall be coincident with the mid-plane of the panel. Tensile testing shall be performed in accordance with ASTM B 557 or ASTM B 557M.

4.4.3.3.1 Additional Testing

If the tensile or yield strengths of any two specimens from the same test panel differ by more than 3000 psi (20.7 MPa) but not more than 5000 psi (34.5 MPa), two additional specimens shall be tested. They shall be excised from locations adjacent to the original pair and equidistant from the center line of the panel. The same procedure shall be followed whenever one or both of the original tests can be positively declared invalid due to a testing machine malfunction or defective specimen(s). No more than four specimens shall be made from the same panel.

4.4.3.4 Test Results

If the spread of tensile or yield strengths from any tests from the same panel is greater than 5000 psi (34.5 MPa), the test in that panel shall be declared invalid. The test may be repeated using another pair of identical panels from the same producer. The results of the substitute tests shall then be incorporated into the results of the groups in place of the invalid tests.

4.4.4 Intergranular Corrosion Resistance

4.4.4.1 Intergranular corrosion test panels from one lot of metal from each of three different producers shall be solution heat treated as specified in AMS2770 using the glycol quenchant maintained at 85 to 90 °F (29 to 32 °C). The glycol concentration used shall be the maximum specified in AMS2770 for the alloy/form/thickness. The tolerance on the glycol concentration shall be +0, 1%. An identical group of specimens shall be solution heat treated and quenched in 85 to 90 °F (29 to 32 °C) water. Specimens shall be aged at room temperature for not less than 96 hours before testing.

4.4.4.2 Intergranular corrosion tests shall be performed in accordance with AMS2772. The microsections shall be examined by two metallographers.

4.5 Reports

4.5.1 When requested by purchaser, the vendor of the quenchant shall furnish a report showing the results of preproduction testing. This report shall include AMS3025C, the results from properties (3.2), quenching capability (3.3), cooling rate (3.3.1), tensile strength (3.3.2) and intergranular corrosion (3.3.3) tests.

4.5.2 The vendor of quenchant shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the quenchant conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS3025C, vendor's compound number, and quantity.

4.5.3 A material safety data sheet conforming to AMS2825, or equivalent, shall be supplied to each purchaser prior to, or concurrent with, the report of preproduction test results or, if preproduction testing be waived by purchaser, concurrent with the first shipment of compound for production usage. Each request for modification of compound formulation shall be accompanied by a revised data sheet for the proposed formulation.

4.6 Resampling and Retesting

If any sample used in the above tests fails to meet the specified requirements, disposition of the quenchant may be based on the results of testing two additional samples for each original nonconforming sample. Failure of any retest sample to meet the specified requirements shall be cause for rejection of the quenchant represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY

5.1 Packaging and Identification

5.1.1 The quenchant shall be packaged in containers of a type and acceptable to purchaser.