



AEROSPACE MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AMS 3025

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Revised

POLYALKYLENE GLYCOL HEAT TREAT QUENCHANT

1. SCOPE:

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

1.2 Application: Primarily for use as a quenching medium for solution heat treatment of aluminum alloys when minimum distortion is required.

1.3 Classification: Quenchants covered by this specification are classified as follows:

Type I - Single Polymer

Type II - Multiple Polymer

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

2. APPLICABLE DOCUMENTS: The following publication form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2202 - Tolerances, Aluminum-Base and Magnesium-Base Alloy Sheet and Plate

AMS 2350 - Standards and Test Methods

AMS 2770 - Heat Treatment of Aluminum Alloy Parts

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B557 - Tension Testing Wrought and Cast Aluminum- and Magnesium- Alloy Products

ASTM D270 - Sampling Petroleum and Petroleum Products

ASTM D445 - Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)

ASTM D1218 - Refractive Index and Refractive Dispersion of Hydrocarbon Liquids

ASTM D1298 - Density, Specific Gravity, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

ASTM E203 - Water Using Karl Fischer Reagent

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

2.3.2 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

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3. TECHNICAL REQUIREMENTS:

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

3.2 Properties of Quenchant: The 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:

3.2.1 As-Received in Concentrated Form:3.2.1.1 Water Content (Chemically Combined, by Volume):

Type I	45 - 48%	ASTM E203
Type II	56 - 59%	

3.2.1.2 Specific Gravity:

Type I	1.100 ± 0.005	ASTM D1298
Type II	1.080 ± 0.002	

3.2.1.3 Refractive Index at 68° F (20° C):

Type I	1.4145 ± 0.0005	ASTM D1218
Type II	1.3955 ± 0.0002	

3.2.1.4 Viscosity at 100° F (38° C):

Type I	$540 \text{ cSt} \pm 65 (0.00054 \text{ m}^2/\text{s})$	ASTM D445
Type II	$300 \text{ cSt} \pm 20 (0.0003 \text{ m}^2/\text{s})$	

3.2.2 Diluted to 20 ± 1% with Water:3.2.2.1 Viscosity at 100° F (38° C):

Type I	$6.0 \text{ cSt} \pm 0.5 (0.000006 \text{ m}^2/\text{s})$	4.5.1
Type II	$4.4 \text{ cSt} \pm 0.5 (0.0000044 \text{ m}^2/\text{s})$	

3.2.2.2 Separation Temperature:

Both Types	$165^\circ \text{F} \pm 5 (74^\circ \text{C} \pm 3)$	4.5.2
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3.3 Quenching Capability: The minimum tests for qualification shall be those specified in Table I.

TABLE I

Required Qualification Tests

Alloy	Form	Panels	Final Temper	Cooling Rate	Tensile and Yield Strength	Intergranular Corrosion Resistance
		Dimensions (1) Inches (mm)				
2024	Bare Sheet	0.063 x 1 x 3 (1.6 x 25 x 75)	T42	-	-	Yes
7075	Bare Sheet	0.063 x 1 x 3 (1.6 x 25 x 75)	W	Yes	-	-
7075	Plate	0.250 x 6 x 9 (6.5 x 150 x 225)	T62	Yes	Yes	-
7075	Forging(2)	1.000 x 5 x 4 (25 x 125 x 100)	T73	Yes	Yes	-
7075	Forging(2)	2.000 x 8 x 7 (50 x 200 x 175)	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 4 times the thickness. Tolerance on width and length are $\pm 1/8$ in. (± 3 mm). Tolerances on thickness of sheet and plate shall be as specified in AMS 2202.

2. Plate may be used to simulate forgings.

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 as follows:

Product Nominal Thickness		Cooling Rate, per sec	
Inch	(Millimetres)	° F	(° C)
0.063	(1.60)	900 - 1800	(500 - 1000)
0.250	(6.35)	240 - 360	(133 - 200)
1.000	(25.40)	50 - 75	(28 - 42)

3.3.2 Strengths: 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 500 psi (3.45 MPa) of those from water-quenched panels, providing that the averages for any single lot of material do not differ by more than 3000 psi (20.7 MPa).

3.3.3 Intergranular Corrosion Resistance: The intergranular corrosion of the panels of 2024 alloy of Table I, 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 product shall not adversely affect its use as a low-distortion quenchant or the material 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 performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.6. Purchaser reserves the right to sample and to perform such confirmatory testing as he deems necessary to ensure that the quenchant conforms to the requirements of this specification.
- 4.2 Classification of Tests:
- 4.2.1 Acceptance Tests: Tests to determine conformance to requirements for water content (3.2.1.1), specific gravity (3.2.1.2), and refractive index as-received (3.2.1.3), and for viscosity (3.2.2.1) and separation temperature (3.2.2.2) of a 20% dilution are classified as acceptance tests and shall be performed on each lot.
- 4.2.2 Qualification Tests: Tests to determine conformance to all technical requirements of this specification are classified as qualification tests and shall be performed on the initial shipment of quenchant to a purchaser, when a change in material or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.
- 4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, qualification test material shall be submitted to the cognizant qualification agency as directed by the procuring activity, the contracting officer, or the request for procurement.
- 4.3 Sampling: Sampling shall be in accordance with ASTM D270. A lot shall consist of one batch or tank offered for delivery at one time. A lot shall not exceed 10,000 gal (37,850 dm³) and may be packaged in smaller quantities and delivered separately under the basic lot approval as long as lot identity is maintained.
- 4.4 Approval:
- 4.4.1 Sample quenchant shall be approved by purchaser before quenchant for production use is supplied, unless such approval be waived. Results of tests on production quenchant shall be essentially equivalent to those on the approved sample.
- 4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production quenchant which are essentially the same as those used on the approved sample quenchant. If any change is necessary in ingredients, in type of equipment for processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in material and processing and, when requested, sample quenchant. Production quenchant made by the revised procedure shall not be shipped prior to receipt of reapproval.
- 4.5 Test Methods:
- 4.5.1 Viscosity: The as-received quenchant shall be diluted to a concentration of 20% $\pm$ 1 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 $\pm$ 3 (38° C $\pm$ 2) in accordance with ASTM D445.
- 4.5.2 Separation Temperature: Shall be determined by heating not less than 250 mL of diluted quenchant, prepared as in 4.5.1, in a glass container to 155° F $\pm$ 1 (68° C $\pm$ 0.5) and observing the solution for separation or stratification of the glycol to form a lower layer. If no separation occurs, increase the temperature at a rate not greater than 1° F (0.5° C) in 5 min. until separation occurs. Record the separation temperature.
- 4.5.3 Cooling Rates: Cooling rates shall be determined by quenching the panels specified in Table I.

- 4.5.3.1 For the 0.250 and 1.0 in. (6.5 and 25 mm) thick panels, an electrically insulated chromel-alumel thermocouple, not larger than 24 gage (0.533 mm) shall be inserted in a blind hole to the midthickness ± 0.020 in. (± 0.5 mm) at the center. The thermocouple shall be inserted and sealed to ensure intimate contact with the panel for optimum thermal transfer and to prevent the intrusion of moisture and quenchant. A second thermocouple of the same size shall be attached on the outside surface to determine the instant the specimen enters the quenchant. Panels shall be deoxidized prior to heating.
- 4.5.3.2 The 0.063 in. (1.6 mm) thick panel shall only have a thermocouple attached to the surface at the center.
- 4.5.3.3 The panels shall be soaked at the solution heat treating temperature as specified in AMS 2770 and quenched in the glycol water solution maintained at 85° to 90° F (30° to 32° C). The glycol concentration used shall be the maximum specified in AMS 2770 for the alloy/form/thickness. The tolerance on the glycol concentration shall be +0%, -1%. The quench tank shall not contain less than 20 gal (75 L) and shall have no agitation.
- 4.5.3.4 The time/temperature cooling curve shall be recorded using a high speed oscillographic recorder. 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.
- 4.5.4 Tensile Properties: Tensile and yield strengths shall be determined in accordance with ASTM B557 on two identical groups of panels; each group shall contain panels from three different lots of metal from each of three different producers.
- 4.5.4.1 Solution Heat Treatment: Solution heat treatment shall conform to AMS 2770. One group of panels shall be quenched in glycol and the other in water. The glycol concentration used shall be the maximum specified in AMS 2770 for the alloy/form/thickness. The tolerance on the glycol concentration shall be +0%, -1%. Quenchant temperature shall be 85° - 90° F (30° - 32° C) except water used for quenching forgings (or plate if used to simulate forgings) shall be 155° - 160° F (68° - 71° C). The quenchant temperature shall not rise more than 10° F (5° C) during quenching. The quenchant shall be agitated vigorously during quenching and the agitation shall be identical for both groups.
- 4.5.4.2 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 AMS 2770 in the same load in the same location within the limitations of good racking practice.
- 4.5.4.3 Testing: One longitudinal tensile specimen shall be excised from each side of the center line of each panel. The tensile specimens made from sheet and plate panels 0.250 in. (6.5 mm) and under in nominal thickness shall be flat and of full thickness. Those made from panels over 0.250 in. (6.5 mm) in nominal thickness shall be round with 0.250 in. (6.25 mm) diameter reduced section and the axis of the specimen shall be coincident with the midplane of the panel. Tensile testing shall be performed in accordance with ASTM B557.
- 4.5.4.3.1 Additional Testing: If the tensile or yield strengths of any pair of specimens differ by more than 3000 psi (20.6 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 4 specimens shall be made from the same panel.
- 4.5.4.4 Test Results: If the spread of tensile or yield strengths from valid tests from the same panel is greater than 5000 psi (34.5 MPa), the test on 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.