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Standard Specification for Anaerobic Single-Component Adhesives (AN)¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers single-component anaerobic adhesives suitable for locking, sealing, and retaining threaded or cylindrical assemblies. The adhesives are cured to a solid state when confined between closely fitting active metal surfaces.

1.2 This specification is intended to be a means of classifying anaerobic adhesives. It is not intended for engineering design purposes.

1.3 This specification is intended to replace Military Specifications MIL-S-22473, MIL-S-46163, and MIL-R-46082.

1.4 The values stated in SI units are to be regarded as the standard.

1.5 The following safety hazards caveat pertains only to the test methods portion, Section 7, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

- A109/A109M Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
- B36/B36M Specification for Brass Plate, Sheet, Strip, and Rolled Bar
- B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- B633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel

¹ This specification is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.60 on Adhesive Material Classification System.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

D56 Test Method for Flash Point by Tag Closed Cup Tester
D439 Specification for Automotive Gasoline (Withdrawn 1990)³

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D770 Specification for Isopropyl Alcohol

D907 Terminology of Adhesives

D1084 Test Methods for Viscosity of Adhesives

D1193 Specification for Reagent Water

D2693 Specification for Ethylene Glycol

D3951 Practice for Commercial Packaging

D4562 Test Method for Shear Strength of Adhesives Using Pin-and-Collar Specimen

D4800 Guide for Classifying and Specifying Adhesives

D5648 Test Method for Torque-Tension Relationship of Adhesives Used on Threaded Fasteners (Lubricity)

D5649 Test Method for Torque Strength of Adhesives Used on Threaded Fasteners

D5657 Test Method for Fluid Tightness Ability of Adhesives Used on Threaded Fasteners

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

2.2 Military Standards:

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes⁴

MIL-STD-129 Marking for Shipment and Storage⁴

MIL-STD-810 Environmental Test Methods and Engineering Guides⁴

MIL-STD-118 Commercial Packaging of Supplies and Equipment⁴

2.3 Federal Standards:

FED-STD-313 Material Safety Data Sheets, Preparation and Submission of⁴

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

2.4 Federal Specifications:

FF-N-836 Nut: Square, Hexagon, Cap, Slotted, Castle, Knurled, Welding and Single Ball Seat⁴
 PPP-B-636 Box, Shipping, Fiberboard⁴
 QQ-P-416 Plating, Cadmium, Electrodeposited⁴

2.5 Military Specifications:

MIL-R-46082 Retaining Compounds, Single-Component, Anaerobic⁴
 MIL-S-22473 Sealing, Locking, Retaining Compounds; Single-Component⁴

MIL-S-46163 Sealing, Lubricating, and Wicking Compounds: Thread-Locking, Anaerobic, Single-Component⁴

MIL-T-5624 Turbine Fuel, Aviation, Grades JP-4 and JP-5⁴

2.6 U.S. Department of Transportation (DOT):

Code of Federal Regulations, Parts 100 to 199, Department of Transportation Rules and Regulations for the Transportation of Explosives and Other Dangerous Articles⁵

2.7 Society of Automotive Engineers:

SAE J311 Fluid for Passenger Care Type Automatic Transmissions, Information Report⁶

SAE J429 Mechanical and Material Requirements for Externally Threaded Fasteners⁶

SAE AMS 2629 Jet Reference Fuel⁶

3. Terminology

3.1 Definitions:

3.1.1 Some terms in this specification are defined in Terminology D907.

3.1.2 *active metal surface, n*—relative to anaerobic adhesives, a metal surface that initiates the formation of free radicals within anaerobic adhesives.

3.1.3 *anaerobic adhesive, n*—an adhesive that is kept in the uncured state by oxygen, as in air, and that cures in the absence of oxygen when exposed to metal ions, especially copper or iron.

3.1.4 *Newtonian behavior, n*—the property of a liquid in which its viscosity is constant over a stated range of strain rates. (Compare *non-Newtonian behavior*.)

3.1.5 *non-Newtonian behavior, n*—the property of a liquid in which its viscosity is not constant over a stated range of strain rates. (Compare *Newtonian behavior*.)

3.1.6 *thixotropy, n*—in a liquid, the property of thinning when subjected to strains greater than the yield strain and of rethickening with time upon subsequent rest.

3.1.6.1 *Discussion*—The liquid must exhibit yield to be thixotropic. If the liquid is deformed more than the yield strain, the underlying elastic network is disrupted and its viscosity is reduced. The network reestablishes itself in time when at rest.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *breakaway torque, n*—the initial torque required to break the bond, measured at the first movement between the nut and the bolt, when unscrewing an unseated assembly.

⁵ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, <http://www.access.gpo.gov>.

⁶ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

3.2.2 *prevailing torque, n*—the torque measured at 180° rotation of the nut.

3.2.2.1 *Discussion*—Prevailing torque was originally defined in MIL-S-46163 and MIL-S-22473 as the average of the four torques measured at 90, 180, 270, and 360° rotation of the nut. Studies have shown that the torque measured at 180° rotation of the nut is statistically equivalent to the average of the torque measured at the four ¼ turns. Since measuring the torque at the one angle of rotation is more efficient, prevailing torque is most often defined as the torque measured at 180° rotation of the nut. However, for purposes of this specification, the definition of prevailing torque as the average of the four torques measured at 90, 180, 270, and 360° rotation of the nut is also acceptable.

4. Classification

4.1 Anaerobic adhesives are classified into groups in accordance with their performance properties. These groups are subdivided into classes and grades, as shown in Table 1.

NOTE 1—For example, the designation AN 0411 would indicate:

AN	=	anaerobic adhesive (from Guide D4800),
04 (Group)	=	retaining compound,
1 (Class)	=	low strength, and
1 (Grade)	=	viscosity of 100–500 mPa.

5. Requirements

5.1 *General Requirements*—General requirements are properties that are inherent in every lot of adhesive produced, but may be tested in accordance with Table 1 at a frequency agreed on by the purchaser and the manufacturer in order to verify specification conformance.

5.1.1 *Ultraviolet Fluorescence*—The uncured adhesive shall fluoresce under ultraviolet illumination when tested in accordance with 7.1.

5.1.2 *Color and Workmanship*—The color supplied shall be the color for the given group, class, and grade, as specified in Table 1. The uncured adhesive shall be smooth and homogeneous after shaking, free from lumps, caked material, and particles of foreign matter when examined in accordance with 7.2.

5.1.3 *Flash Point*—The uncured adhesive shall have a flash point above 93°C when tested in accordance with 7.3.

5.1.4 *Storage Stability*—The strength shall conform to the properties specified for the given class in Table 1. The viscosity shall increase no more than 50 % above the uppermost limit for the given grade in Table 1 when tested in accordance with 7.12.

5.1.5 *Toxicity*—The supplier shall furnish a Material Safety Data Sheet (MSDS) in accordance with FED-STD-313 so that the user can evaluate the safety of the material for the proposed use.

5.1.6 *Solvent Resistance*—The average strength of each adhesive, after solvent immersion testing in accordance with 7.11, shall meet the requirements specified for the given class in Table 1.

5.1.7 *Hot Strength*—The average strength of each adhesive, after hot-strength testing in accordance with 7.8, shall meet the requirements specified for the given class in Table 1.



TABLE 1 AN Basic Properties—Anaerobic Adhesives
Group 1 Products

Group	Description	Class	Description	Grade	Color (5.1.2)	Strength at Standard Conditions, Prevailing Torque Strength (5.2.3.1), N·m	Viscosity (5.2.1), mPa·s	Solvent Resistance (5.1.6), Prevailing Torque, N·m, min	Hot Strength (5.1.7), Prevailing Torque, N·m, min	Heat Aging (5.1.8), Prevailing Torque, N·m, min	Cold Strength (5.1.9), Prevailing Torque, N·m, min	Speed of Cure (5.2.2), Prevailing Torque, N·m, min		
01	Threadlocking and retaining adhesives; slow curing; Newtonian flow properties	1		1	green	17.0–42.4	10–25	17.0	10.2 ^A	8.5 ^A	17.0	8.5		
				0										
		2				1	red	11.3–28.2	10–25	11.3	6.8 ^A	5.6 ^A	11.3	5.6
						2	orange	11.3–28.2	40–80	11.3	6.8 ^A	5.6 ^A	11.3	5.6
						3	red	11.3–28.2	100–250	11.3	6.8 ^B	5.6 ^A	11.3	5.6
						4	red	11.3–28.2	1000–10000	11.3	6.8 ^B	5.6 ^A	11.3	5.6
		3				1	yellow	7.9–19.8	100–200	7.9	4.7 ^B	3.9 ^A	7.9	3.9
						0								
		4				1	blue	4.5–11.3	10–25	4.5	2.7 ^A	2.3 ^A	4.5	2.3
						2	blue	4.5–11.3	100–250	4.5	2.7 ^B	2.3 ^A	4.5	2.3
						3	blue	4.5–11.3	1000–10000	4.5	2.7 ^A	2.3 ^A	4.5	2.3
		5				1	purple	2.3–5.6	10–25	2.3	1.3 ^A	1.1 ^A	2.3	1.1
						2	purple	2.3–5.6	100–250	2.3	1.3 ^B	1.1 ^A	2.3	1.1
6				1	brown	1.1–2.8	10–25	1.1	0.7 ^A	0.6 ^A	1.1	0.6		
				2	brown	1.1–2.8	100–250	1.1	0.7 ^B	0.6 ^A	1.1	0.6		
				3	brown	1.1–2.8	1000–10000	1.1	0.7 ^A	0.6 ^A	1.1	0.6		
7				1	yellow	0.8–1.5	100–250	0.8	0.4 ^A	0.4 ^A	0.8	0.4		
				0										
0			other	0										



TABLE 1 AN
Groups 2 and 3 Products
(continued)

Group	Description	Class	Description	Grade	Color (5.1.2)	Strength at Standard Conditions, Torque Strength (5.2.3.1), N·m						Viscosity (5.2.1), mPa·s	Solvent Resistance (5.1.6), N·m, min		Hot Strength (5.1.7), N·m, min ^A			
						Steel			Plated				Break	Prevail	Break	Prevail	Break	Prevail
						Break	Prevail	Break	Break	Prevail								
02	Threadlocking adhesives; fast curing; Newtonian flow properties	1	red	1	16.9–39.5	16.9–56.5	5.6–39.5	4.5–56.5	8.4	8.4	8.4	8.4	8.4	8.4 ^C				
				0	16.9–39.5	16.9–56.5	4.5–39.5	4.5–56.5	8.4	8.4	8.4	8.4 ^A						
		3	blue	1	11.3–22.6	5.6–17.0	3.4–22.6	2.3–22.6	5.6	2.8	5.6	2.8 ^C						
				0	11.3–22.6	2.3–11.3	1.1–11.3	1.1–11.3	1.1	1.1	1.1	1.1 ^C						
		5	blue	1	2.3–11.3	11.3–22.6	1.7–22.6	1.7–22.6	1.1	5.6	1.1	5.6 ^C						
				0	2.3–11.3	17.0–56.5	1.1–11.3	8.5–56.5	1.1	8.5	1.1	8.5 ^A						
03	Threadlocking adhesives; fast curing; thixotropic flow properties; lubricating	1	purple	0	3.4–11.3	1.1–11.3	1.1–11.3	0.6–11.3	1.7	0.5	1.7	1.7	0.5 ^C					
				1	3.4–11.3	1.1–11.3	1.1–11.3	0.6–11.3	at 2 rpm ≥ 5000 at 20 rpm 800–1600	0.5	1.7	1.7	0.5 ^C					
		2	blue	1	7.9–22.6	2.3–22.6	1.1–22.6	0.6–22.6	3.9	1.1	3.9	1.1 ^B						
				0	7.9–22.6	11.3–33.9	5.6–28.2	5.6–28.2	at 2 rpm ≥ 5000 at 20 rpm 800–1600	1.1	3.9	3.9	1.1 ^B					
		3	red	1	11.3–28.2	11.3–33.9	5.6–28.2	5.6–28.2	5.6	5.6	5.6	5.6 ^A						
				0	11.3–28.2	11.3–33.9	5.6–28.2	5.6–28.2	at 2 rpm ≥ 5000 at 20 rpm 1200–2400	5.6	5.6	5.6	5.6 ^A					
0	other	0	other	0	other	other	other											

TABLE 1 AN
Groups 2 and 3 Products
(continued)

Group	Description	Class	Description	Grade	Color (5.1.2)	Heat Aging (5.1.8), N-m, min ^A		Cold Strength (5.1.9), N-m, min		Speed of Cure (5.2.2), N-m, min	
						Break	Prevail	Break	Prevail	Break	Prevail
02	Threadlocking adhesives; fast curing; Newtonian flow properties	1		1	red	8.4	8.4 ^C	8.4	8.4	8.4	8.4
				0							
		2		1	red	8.4	8.4 ^A	8.4	8.4	8.4	8.4
				0							
		3		1	blue	5.6	2.8 ^C	5.6	2.8	5.6	2.8
				0							
03	Threadlocking adhesives; fast curing; thixotropic flow properties; lubricating	4		1	blue	1.1	1.1 ^C	1.1	1.1	1.1	1.1
				0							
		5		1	blue	1.1	5.6 ^C	1.1	5.6	1.1	5.6
				0							
		6		1	green	1.1	8.5 ^A	1.1	8.5	1.1	8.5
				0							
0		1	purple	1.7	0.5 ^C	1.7	0.5	1.7	0.5		
		0									
03	Threadlocking adhesives; fast curing; thixotropic flow properties; lubricating	2		1	blue	3.9	1.1 ^B	3.9	1.1	3.9	1.1
				0							
				1	red	5.6	5.6 ^A	5.6	5.6	5.6	5.6
0		0									



TABLE 1 AN
Group 4 Products (continued)

Group	Description	Class	Description	Grade	Color (5.1.2)	Strength at Standard Conditions, Shear Strength (5.2.3.2), ASTM D4562 MPa, min	Viscosity (5.2.1), mPa·s	Solvent Resistance (5.1.6), MPa, min	Hot Strength (5.1.7), MPa, min	Heat Aging (5.1.8), MPa, min	Cold Strength (5.1.9), MPa, min	Speed of Cure (5.2.2), MPa, min
04	retaining adhesives	1		1 2 0	green green	13.8 13.8	100-500 400-800	10.3 10.3	6.9 ^A 10.3 ^A	10.3 ^A 12.4 ^A	13.8 13.8	
		2		1 0 0	green	24.1	1500-2500	10.3	6.9 ^A	10.3 ^A	17.2	
00	other ^{B,C}	0 0	other other	0 0								

^A Test temperature = 150°C.

^B Test temperature = 93°C.

^C Test temperature = 121°C.