Designation: D 3519 – 88 (Reapproved 2002)

An American National Standard

Standard Test Method for Foam in Aqueous Media (Blender Test)[1]

This standard is issued under the fixed designation D 3519; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the measurement of the increase in volume of a low-viscosity aqueous liquid (less than 3 cSt at 40°C) due to its tendency to foam under high shear conditions.

NOTE 1—Foam under low shear is covered by Test Method D 3601.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for information only.

1.3 *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.* For specific safety information, see 7.16.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1126 Test Method for Hardness in Water[2]

D 3601 Test Method for Foam In Aqueous Media (Bottle Test)[3]

3. Summary of Test Method

3.1 The increase in volume is determined by the increase in total height of test fluid including foam after blending for 30 s using a commercial-type blender with glass jar (see Note 2) at 25 ± 1°C (77 ± 1.8°F) agitating between 4000 and 13 000 rpm. The preferred range would be 8000 ± 1000 rpm.

4. Significance and Use

4.1 The results obtained by the test method described are useful as guides in determining the tendency of a water-based metalworking coolant to produce foam under high shear conditions. No correlation with changes in heat transfer, pumpability, or other factors affected by foam is intended. The foam produced by any given industrial process depends on the method by which the foam is generated and may not be directly proportional to that produced by this carefully controlled laboratory test method. Further, the foam generated at the specified test temperature will not necessarily predict the foaming tendency of the liquid (that is, metalworking coolant) at some other use temperature.

5. Apparatus

5.1 *Blender*.

NOTE 2—Tests with blenders other than commercial 7-speed Waring Blendor Model 5012G or Model 91-264 (7012G), as shown in Fig. 1, may be suspect due to differences in speed or shape of the jar.[4] The blender speed should be calibrated by any reliable means. One means can be to use a hand-contact tachometer to get the order of speed and then to get several more precise determinations using a stroboscope (which does not touch the rotor). Settings then can be selected to obtain the recommended speed.

5.2 *Water Bath*, constant-temperature, suitable to hold blender jar and several bottled emulsions at 25 ± 1°C (77 ± 1.8°F) for 1 to 2 h.[5]

5.3 *Stop Watch* or *Timer*, capable of measuring 5 min ± 0.2 s.

5.4 *Glass Jars* or *Bottles*, clean or new, 250-ml (8-oz) or 500-ml (16-oz).

5.5 *Graduated Cylinder*, 250-ml, fitted with ground-glass stopper.

5.6 *Rule*, millimetre, approximately 300 mm long to be attached to the blender jar.

6. Materials

6.1 *Distilled Water*.

6.2 *Hard Water*, 20 000 ppm, made as follows: Dissolve 29.4 g of reagent grade (ACS standard) $CaCl_2 \cdot 2H_2O$ in 1 L of freshly boiled distilled water. (Used only where distilled water is used as in Note 3.)

7. Procedure

7.1 Clean and rinse the blender with distilled water using 10 s blends and fresh samples of distilled water until no appreciable foam is developed by blending.

7.2 Place the blender jar in the constant-temperature bath. (The bath water should not be allowed inside the jar.)

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[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.L0.01 Metal Removal Fluids and Lubricants.

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[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 05.02.

[4] Except for exterior finish of the base, Blendor Models 5012G and 7012G (91-264) are the same. Blendors may be purchased from Waring Products Div., or through supply houses (such as Cole Palmer No. 4244-80).

[5] A common household dishpan is satisfactory when the test temperature is close to room temperature.

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FIG. 1 Commercial Blender (See Note 1).

1. **Preparation of Emulsion**
   - 1.1 (7.3) Sample description
   - 1.2 (7.3) Concentration, %
   - 1.3 (7.4) Source of water used
   - 1.4 (7.4) Water hardness, ppm
   - 1.5 (7.3) Method of preparing emulsion

2. **Test Data**

2.1 (7.9)	Temperature at start of test	°C
2.2 (7.10)	Initial height (*I*)	mm
2.3 (7.12)	Maximum total height at zero time (*M*)	mm
2.4 (7.14)	Residual total height after 5 min (*R*)	mm
2.5 (7.13)	Time to defoam to 10 mm (to nearest ½ min)	min
2.6 (7.15)	Temperature at end of test	°C

Caution—The round robin on this test used distilled water and a controlled synthetic hard water to make data comparative to the products under test at different places and at different times. Care must be exercised when natural waters are used that comparative samples are used in exactly the same water, taken at the same time from the same source. (For instance, well waters can change in hardness rapidly depending on the change in demand within the hour.)

NOTE 1—Numbers in parentheses indicate the section within the body of the method where the observations to be recorded are made.

FIG. 2 Suggested Test Form for Recording Data.

7.3 Using the manufacturer's recommended procedure, prepare 200 ml of emulsion at the recommended use concentration.

7.4 When tap water is used, record water hardness (using Test Method D 1126), source, and date obtained.

NOTE 3—In the absence of manufacturers' recommendations, place 190 ml of distilled water in the 250-ml capacity glass-stoppered graduated cylinder. Pour a fine stream of coolant concentrate into the cylinder to bring the liquid level to the 200-ml mark, being careful not to run concentrate down the side of the cylinder. (A syringe or serological pipet with rubber bulb may be found convenient here.[6]) Immediately, stopper and shake the cylinder to form a 5 % emulsion or solution.

7.5 Pour the test liquid into a clean glass bottle or jar and store it at 25 ± 1°C (77 ± 1.8°F) for a minimum of 1 h and a maximum of 2 h in the constant-temperature water bath deep enough so that the water level is at least 10 mm above the air-test fluid interface.

7.6 Assemble the blender.

7.7 Attach a millimetre rule to one side of the blender so that the 0 mm matches with the inside bottom of the blender jar.

NOTE 4—Permanent attachment using epoxy cement may be found to

[6] Serological pipets, Corning No. 7077 or Fisher No. 13-671-108E, are suitable for more viscous fluids.

SAMPLES OF DATA (Blender Method) Millimetres Maximum Foam: *M – I*

		Sample Number											
		1	2	3	4	5	6	7	8	9	10	11	12
	X_1[A]	65	70	50	45	105	110	85	10	90	25	80	15
6	X_2[A]	65	65	50	35	105	90	75	15	85	25	80	25
	X_1	0	0	0	0	90	70	80	2	95	30	90	20
14	X_2	0	0	0	0	70	70	80	3	98	30	90	28
		Millimetres Residual Foam: *R – I*											
	X_1	0	0	0	0	60	70	75	0	85	10	80	15
6	X_2	0	0	0	0	55	30	70	0	85	15	80	10
	X_1	0	0	0	0	90	70	80	2	95	30	90	20
14	X_2	0	0	0	0	70	70	80	3	98	30	90	28
		Time to Defoam to 1 cm Net Foam Level (min)											
	X_1	0.33	0.5	0.25	0.25	5 +	5 +	5 +	0	5 +	5.0	5 +	5 +
6	X_2	0.5	0.5	0.25	0.25	5 +	5 +	5 +	0	5 +	5 +	5 +	5 +
	X_1	0.25[B]	0.25[B]	0.25[B]	0.25[B]	5 +	5 +	5 +	0.25[B]	5 +	5 +	5 +	5 +
14	X_2	0.25[B]	0.25[B]	0.25[B]	0.25[B]	5 +	5 +	5 +	0.25[B]	5 +	5 +	5 +	5 +

[A] X_1 and X_2 are duplicate test results.
[B] Request was for nearest 0.5 min. Where <0.5 min is shown, it was recorded at 0.25 min.

Blender Descriptions	rpm
6 Waring 5012G—speed 1	7 300
14 Waring 1003—low speed	11 000

Sample Descriptions

Sample
1 L-1-3A in Distilled Water—10 % butyl Cellosolv® (trademark of Union Carbide)
3 L-1-3B in Distilled Water—10 % butyl Carbitol® (trademark of Union Carbide)
5 L-1-3C in Distilled Water—Sample 3 plus nonionic ether
7 L-1-3D in Distilled Water—5 % commercial long oil soluble coolant
9 L-1-3E in Distilled Water—3 % commercial synthetic coolant
11 L-1-3F in Distilled Water—3 % commercial synthetic plus defoamer
2,4,6,8,10,12—Same in hard water, respectively

FIG. 3 Sample Data (Blender Method).

be convenient. An adhesive-backed transparent measuring tape is also suitable.[7]

7.8 Pour the test liquid into the blender jar.

7.9 Using any suitable thermometer, measure and record the temperature of this liquid and adjust it to 25 ± 1°C (77 ± 1.8°F) if necessary. Remove the thermometer and cover the blender jar.

7.10 Measure and record the test liquid height, disregarding any foam, to the nearest 1 mm. Call this the initial height, *I*.

7.11 Blend 30 ± 1 s at between 4000 and 13 000 rpm.

7.12 Shut off the blender and immediately measure the total height (including foam). This is called maximum total height at zero time. (If foam is not level, make the best average measurement possible.)

7.13 Allow the blender to stand undisturbed and record the time (to the nearest ½ min) for the foam to subside to a net foam height of 10 mm.

7.14 Record the total height to the nearest 1 mm as residual total height after 5 min if the foam height at this time exceeds 10 mm.

7.15 Measure and record the temperature of the test liquid to the nearest 1°C (1.8°F).

NOTE 5—The following sections should be performed only when distilled water has been used in the above procedure in accordance with Note 3.

7.16 Add 1.0 ml of 20 000-ppm hard water stock solution to the emulsion. Blend on No. 1 or the lowest speed for 5 s to distribute the hard water stock uniformly. Allow the emulsion to sit quiet for 5 min; then proceed as in 7.17. (**Warning**—Differences in hydrolyzation time can yield differences in foaming properties.)

7.17 Repeat 7.9-7.15 .

7.18 Rinse the blender as in 7.1.

NOTE 6—7.2 may be omitted prior to testing of other fluids in a single series of tests, provided a jar temperature approximating 25°C (77°F) is assured.

8. Calculations and Report

8.1 Calculate maximum foam height, F_m, as follows:

$$F_m = M - I \quad (1)$$

where:
I = initial height (7.10), and
M = maximum total height at zero time (7.12).

8.2 *Time to Defoam to 10 mm (7.13)*—Record the time to defoam to 10 mm of net foam to the nearest 0.5 min if foam subsides within the 5-min test time. Otherwise record "5 + ."

8.3 Calculate residual foam after 5 min, *Fr*, as follows:

$$F_r = R - I \quad (2)$$

where:
R = residual total height (7.14)

NOTE 7—A suitable report form is described in Fig. 2.

[7] One suitable transparent tape is sold under the brand "Scalefix Scales" by Bel-Art Products Inc., Pequannock, NJ, Catalog No. H-2075 (1974).

9. Precision and Bias [8]

9.1 The precision of the method as determined by the statistical examination of interlaboratory test results is as follows:

9.1.1 *Repeatability*—The difference between successive test results, obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, and in the normal and correct operation of the test method, exceed the following values only in one case in twenty:

	Mean %
Maximum foam	25
Residual foam	24

9.1.2 *Reproducibility*—The difference between two, single and independent results, obtained by different operators working in different laboratories on identical test material would, in the long run, exceed the following values only in one case in twenty:

	Mean %
Maximum foam	70
Residual foam	43

9.2 *Bias*—Since there is no accepted reference suitable for determining the bias for the procedure in this test method, no statement on bias is being made.

NOTE 8—*Time to Defoam* data are not usable to determine precision by the prescribed method as most data read either less than 0.5 min, or 5 + min. See Fig. 3 for sample data.

NOTE 9—*Referee Work*—No more than three replicate tests will normally be required.

10. Keywords

10.1 aqueous media; blender test; foam; high shear; water based metal working coolant

[8] The results of the cooperative round-robin test program from which these values have been derived are filed at ASTM International Headquarters. Request RR:D-2-1024.

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