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Standard Test Method for Foaming Characteristics of Lubricating Oils¹

This standard is issued under the fixed designation D 892; 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.

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

This test method has been approved by the sponsoring committees and accepted by the cooperating societies in accordance with established procedures.

1. Scope

1.1 This test method covers the determination of the foaming characteristics of lubricating oils at 24°C and 93.5°C. Means of empirically rating the foaming tendency and the stability of the foam are described.

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

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 hazard statements, see Sections 7, 8, and 9.1.1.

2. Referenced Documents

2.1 ASTM Standards:

D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids²

D 4175 Terminology Relating to Petroleum, Petroleum Products, and Lubricants³

E 1 Specification for ASTM Thermometers⁴

E 128 Test Method for Maximum Pore Diameter and Permeability of Rigid, Porous Filters for Laboratory Use⁵

3. Terminology

3.1 Definitions:

3.1.1 *diffuser, n*—for gas, a device for dispersing gas into a fluid.

3.1.1.1 *Discussion*—In this test method the diffuser may be made of either metallic or non-metallic materials.

3.1.2 *foam, n*—in liquids, a collection of bubbles formed in the liquid or on (at) its surface in which the air (or gas) is the major component on a volumetric basis.

3.1.3 *entrained air (or gas), n*—in liquids, a two-phase mixture of air (or gas) dispersed in a liquid in which the volume of the liquid is the major component.

3.1.3.1 *Discussion*—The air (or gas) is in the form of discrete bubbles of about 10 to 1000 μm in diameter. The bubbles are not uniformly dispersed. In time they tend to rise to the surface to coalesce to form larger bubbles which break or form foam. Subsurface coalescence can also occur, in which case, the bubbles rise more rapidly.

3.1.4 *lubricant, n*—any material interposed between two surfaces that reduces the friction or wear between them.

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3.1.4.1 *Discussion*—In this test method, the lubricant is an oil which can or can not contain additives such as foam inhibitors.

3.1.5 *maximum pore diameter, n*—in gas diffusion, the diameter a capillary of circular cross section which is equivalent (with respect to surface tension effects) to the largest pore of the diffuser under consideration.

3.1.5.1 *Discussion*—The pore dimension is expressed in micrometres in this test method.

3.1.6 *permeability, n*—in gas diffusion, the flow of gas, through the gas diffuser.

3.1.7 *Discussion*—In this test method, the permeability is measured at a pressure of 2.45 kPa (250 mm of water) in millilitres per minute.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *dynamic bubble, n*—the first bubble to pass through and escape from the diffuser followed by a continuous succession of bubbles when testing for the maximum pore diameter in Annex A1.

3.2.1.1 *Discussion*—When a diffuser is immersed in a liquid, air can be trapped in the pores. It can escape eventually or as soon as a pressure is applied to the diffuser. When testing for maximum pore diameter (Annex A1) the escape of such bubble shall be ignored.

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.06 on Analysis of Lubricants.

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In the IP, this method is under the jurisdiction of the Standardization Committee.

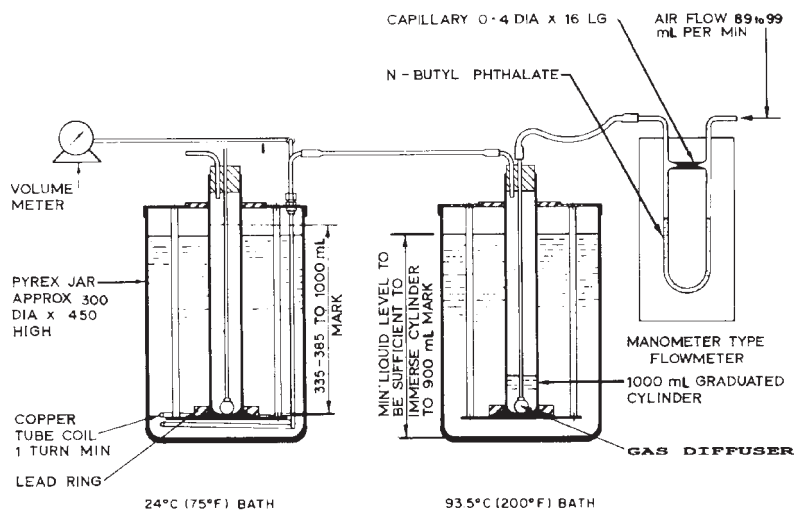
² *Annual Book of ASTM Standards*, Vol 05.01.

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

⁴ *Annual Book of ASTM Standards*, Vol 14.03.

⁵ *Annual Book of ASTM Standards*, Vol 14.02.

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All dimensions in millimetres.

FIG. 1 Foaming Test Apparatus

3.2.2 *foam stability, n*—in foam testing, the amount of foam remaining at the specified time following the disconnecting of the air supply.

3.2.2.1 *Discussion*—In this test method, foam stability is determined from measurements made 10 min ± 10 s after disconnecting the air supply.

3.2.3 *foaming tendency, n*—in foam testing, the amount of foam determined from measurements made immediately after the cessation of air flow.

4. Summary of Test Method

4.1 The sample, maintained at a temperature of 24°C (75°F) is blown with air at a constant rate for 5 min, then allowed to settle for 10 min. The volume of foam is measured at the end of both periods. The test is repeated on a second sample at 93.5°C (200°F), and then, after collapsing the foam, at 24°C (75°F).

5. Significance and Use

5.1 The tendency of oils to foam can be a serious problem in systems such as high-speed gearing, high-volume pumping, and splash lubrication. Inadequate lubrication, cavitation, and overflow loss of lubricant can lead to mechanical failure. This test method is used in the evaluation of oils for such operating conditions.

6. Apparatus

6.1 *Foaming Test Apparatus*, shown in Fig. 1, consisting of a 1000-mL graduated cylinder fitted with a heavy ring to overcome the buoyancy, and an air-inlet tube, to the bottom of which is fastened a gas diffuser. The gas diffuser can be either

a 25.4-mm (1-in.) diameter spherical gas diffuser stone⁶ made of fused crystalline alumina grain, or a cylindrical metal diffuser⁷ made of sintered five micron porous stainless steel (Note 1). The cylinder shall have a diameter such that the distance from the inside bottom to the 1000-mL graduation mark is 360 ± 25 mm. It shall be circular at the top (Note 2) and shall be fitted with a rubber stopper having one hole at the center for the air-inlet tube and a second hole off-center for an air-outlet tube. The air-inlet tube shall be adjusted so that, when the rubber stopper is fitted tightly into the cylinder, the gas diffuser (Note 3) just touches the bottom of the cylinder and is approximately at the center of the circular cross section. Gas diffusers shall meet the following specification when tested in accordance with the method given in Annex A1:

Maximum pore diameter, μm	Not greater than 80
Permeability at pressure of 2.45 kPa (250 mm) water, mL of air/min	3000 to 6000

NOTE 1—Gas diffuser permeability and porosity can change during use; therefore, it is recommended that diffusers be tested when new and periodically thereafter preferably after each use.

NOTE 2—Graduated cylinders with circular tops can be prepared from cylinders with pouring spouts by cutting them off below the spouts. The cut surface is to be smoothed before use by fire polishing or grinding.

NOTE 3—Gas diffusers may be attached to air-inlet tubes by any suitable means. A convenient arrangement is shown in Fig. 2.

6.2 *Test Baths*, large enough to permit the immersion of the cylinder at least to the 900-mL and capable of being

⁶ Suitable diffuser stones can be obtained from the Norton Co., Industrial Ceramics Div., Worcester, MA 01606, under the designation AX536, Alundum porous spheres.

⁷ Suitable metal diffusers can be obtained from Petrolab Corp., 874 Albany-Shaker Road, Latham, NY 12110 under the designation M13-0653. The names of suitable suppliers of diffuser stones and metal diffusers in the United Kingdom may be obtained from the Institute of Petroleum.

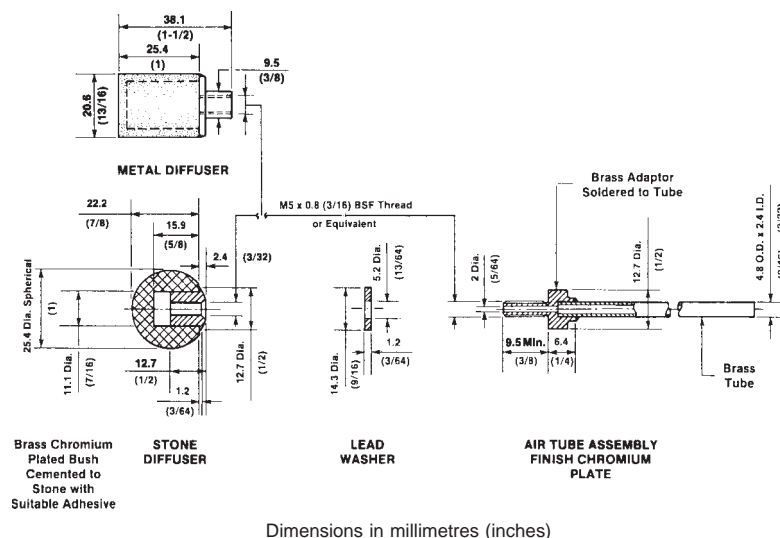


FIG. 2 Attachment of Gas Diffusers to Air-Inlet Tubes

maintained at temperatures constant to 0.5°C (1°F) at 24°C (75°F) and 93.5°C (200°F), respectively. Both bath (Note 5) and bath liquid shall be clear enough to permit observation of the graduations on the cylinder.

NOTE 4—Air baths may also be utilized for heating purposes. Limited data has shown that both liquid and air baths give equivalent results. However, the precision estimates given in Section 13 are based on using only liquid baths.⁸

NOTE 5—Heat-resistant cylindrical glass jars approximately 300 mm (12 in.) in diameter and 450 mm (18 in.) in height make satisfactory baths.

6.3 *Air Supply*, from a source capable of maintaining an air flow rate of 94 ± 5 mL/min through the gas diffuser. The air shall be passed through a drying tower 300 mm in height packed as follows: just above the constriction place a 20-mm layer of cotton, then a 180-mm layer of indicating desiccant, and a 20-mm layer of cotton. The cotton serves to hold the desiccant in place. Refill the tower when the indicating desiccant begins to show presence of moisture. A flowmeter sensitive to the required tolerances can be used to measure the air flow (Note 6).

NOTE 6—A manometer type flowmeter, in which the capillary between the two arms of the U-tube is approximately 0.4 mm in diameter and 16 mm in length, and in which *n*-butylphthalate is the manometric liquid, is suitable.

6.3.1 The total volume of air leaving the foaming test apparatus shall be measured by a volume measuring device (Note 8) capable of accurately measuring gas volumes of about 470 mL. The air shall be passed through at least one loop of copper tubing placed around the inside circumference of the cold bath so that the volume measurement is made at approximately 24°C (75°F). Precautions are to be taken to avoid leaks at any point in the system.

NOTE 7—Alternatively, a 1 L cylinder (with 10 mL graduation marks) full of water is inverted in a tall, large beaker also filled with water. There should be no air bubbles inside. Air leaving the copper loop in the bath is

connected below the cylinder. When the test is started, air will flow into the cylinder, displacing the water. At the end of the test, the volume of air in the cylinder is measured by equalizing the water levels inside and outside the cylinder. Alternatively, the total volume of air passed would be the difference between the final and the initial volumes of water in the cylinder.

NOTE 8—A wet test meter calibrated in hundredths of a litre is suitable.

6.4 *Timer*, graduated and accurate to 1 s or better.

6.5 *Thermometer*, having a range as shown below and conforming to the requirements as prescribed in Specification E 1 or specifications for IP thermometers:

Temperature Range	Thermometer	No. IP
-5 to 215°F	ASTM 12F	64F
-20 to 102°C	12C	64C

7. Reagents and Materials

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all cases. Unless indicated otherwise, it is intended that all reagents conform to the specifications of the committee on Analytical Reagents of the American Chemical Society where such specifications are available.⁹ Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 *Acetone*—(Warning—Extremely flammable, vapors can cause a flash fire).

7.3 *Compressed Air*, hydrocarbon free and dry to a dew point of -60°C or lower.

NOTE 9—If the source of compressed air is ensured to the stated specifications, the drying tower in 6.3 may not be necessary.

7.4 *Heptane*—(Warning—Flammable, vapor harmful).

⁹ *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

⁸ Supporting data has been filed at ASTM International Headquarters. Request RR: D02-1516.