Designation: D7840 – 12 (Reapproved 2017)

Standard Test Method for Foaming Tendencies of Non-Aqueous Engine Coolants in Glassware[1]

This standard is issued under the fixed designation D7840; 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 a simple glassware test for evaluating the tendency of non-aqueous engine coolants to foam under laboratory controlled conditions of aeration and temperature.

1.2 *Units*—The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this 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 warning statements, see 7.2 and 7.3.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1193 Specification for Reagent Water
E1 Specification for ASTM Liquid-in-Glass Thermometers
E128 Test Method for Maximum Pore Diameter and Permeability of Rigid Porous Filters for Laboratory Use
E230/E230M Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *break time, n*—time required for the foam to collapse (after the air supply has been shut off) to the first appearance of an "eye" on the surface of the test solution.

3.1.2 *eye, n*—appearance of foam-free area on the surface of the test coolant surrounded by a ring of foam clinging to the cylinder walls.

4. Summary of Test Method

4.1 The non-aqueous coolant of interest is blown with air at a constant rate for 5 min while maintained at a constant temperature of 88 ± 1 °C by means of a suitable temperature bath. The volume of foam and the time for such foam to break are measured.

5. Significance and Use

5.1 In the test method, coolants generally will be distinguished that have a tendency to foam excessively from those that are suitable for further evaluation to determine performance in actual service.

NOTE 1—In use, the foaming tendency of a coolant solution may be increased by service aging or contamination. A properly functioning pressure cap will tend to suppress foaming in coolant solutions.

6. Apparatus

6.1 *Container,* a 500-mL graduated container of heat-resistant glass having a diameter of 45 to 50 mm and a length of 380 mm.

6.2 *Temperature Bath,* a heat-resistant glass container large enough to permit immersion of the graduated container at least to the 350-mL graduation mark. A 4000-mL beaker is satisfactory.

6.3 *Heat Source,* any heating system capable of maintaining a uniform bath temperature of ±1 °C. A 750-W electric hot plate is satisfactory.

6.4 *Aerator Tube,* a 25.4-mm diameter spherical gas-diffuser stone[3] made of fused crystalline alumina grain that meets the following specifications when tested in accordance with the method given in Annex A1:

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[1] This test method is under the jurisdiction of ASTM Committee D15 on Engine Coolants and Related Fluids and is the direct responsibility of Subcommittee D15.22 on Non-Aqueous Coolants.

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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.

[3] For information on aerator supplier and specifications, contact ASTM Subcommittee D15.06 through ASTM International Headquarters.

Maximum pore diameter, µm	Not greater than 80
Permeability at a pressure of 2.45 kPa, mL of air/min	3000 to 6400

6.5 *Temperature Measuring Instrument (Environmentally Safe Thermometer or Thermocouple)*—An ASTM Partial Immersion Temperature Measuring Instrument having a range from –20 to 150 °C (0 to 302 °F) and conforming to the requirements for Thermometer 1C (1F), as prescribed in Specification E1 or Thermocouple as summarized in Specification E230/E230M.

6.6 *Air Supply,* a clean and dry source, free from grease and other contaminants, capable of maintaining the prescribed flow rate through the diffuser stone.

6.7 *Timer,* a stop watch or suitable timing device accurate to ±0.2 s.

6.8 *Vent,* a three-way stopcock inserted in the metered air supply line immediately ahead of the aerator tube.

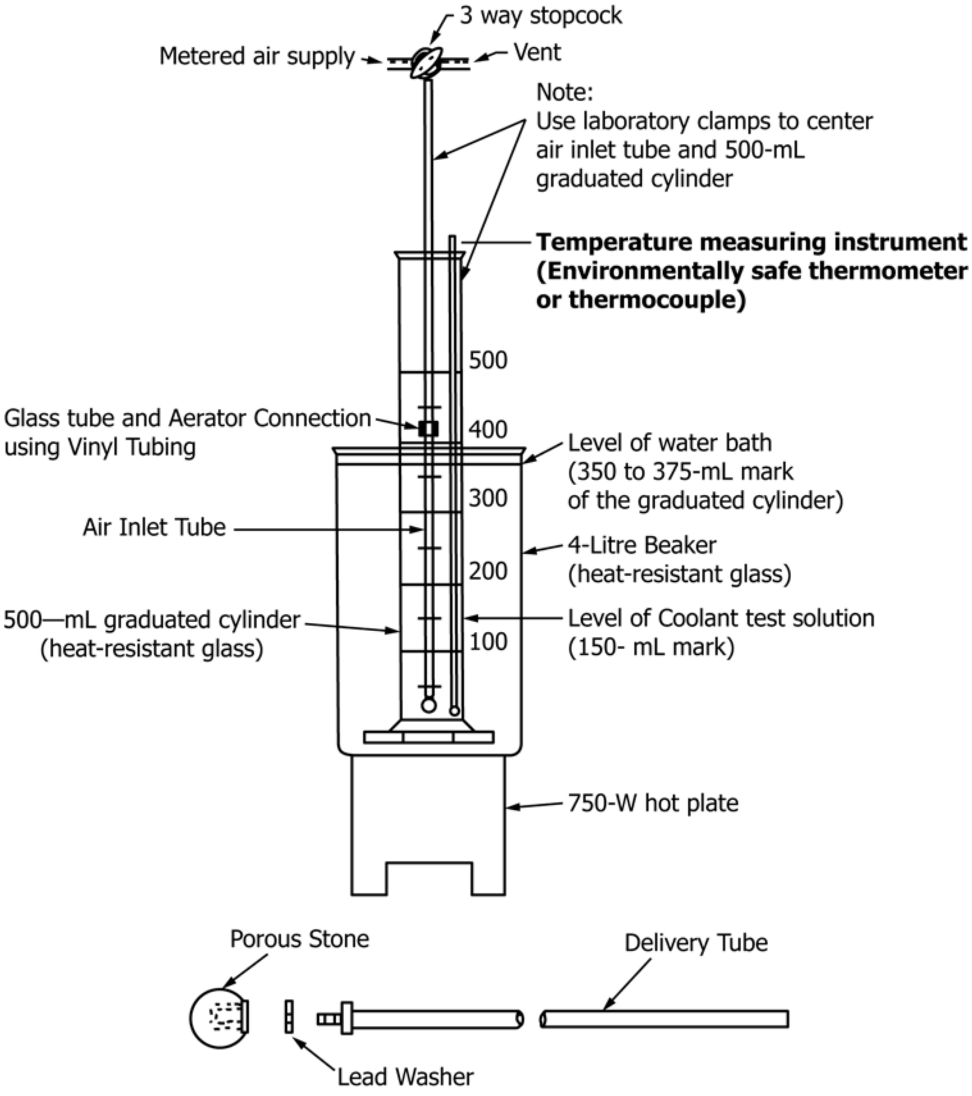
6.9 *Typical Assembly Setup,* a typical apparatus using a hot-plate heat source is shown in Fig. 1.

7. Reagents and Materials

7.1 *Purity of Water*—Unless otherwise indicated, references to water means reagent water as defined by Type II of Specification D1193.

7.2 *Acetone,* for flushing and drying the test equipment. (**Warning—**Acetone is extremely flammable.)

7.3 *Cleaning Bath*—Refers to an acid or base cleaning solution used to clean glassware between tests. The choice of cleaning baths depends on individual needs. For example,



Attachment of Diffuser Stones to Air-Inlet Tubes

FIG. 1 Schematic Drawing of Apparatus for Glassware Foam Test

Nochromix® and alcoholic sodium (potassium) hydroxide are common acid and base cleaning baths, respectively.[4] (**Warning—**The cleaning baths are strong oxidants and strong acid and base, respectively. Avoid contact with skin, eyes, and clothing. Do not breathe vapor. Handle in a fume hood.)

8. Test Coolant

8.1 The non-aqueous coolant is intended to be tested as-is, without dilution or adulteration of any kind.

9. Conditioning

9.1 *Test Temperature*—The temperature bath shall be kept at a constant volume (350- to 375-mL mark of the graduated cylinder) throughout the test. The reference and test coolants shall be maintained at 88 ± 1 °C throughout.

9.2 *Aeration Rate*—The aeration rate shall be 1000 ± 25 mL/min.

9.3 *Number of Tests*—The non-aqueous test coolant shall be tested in triplicate using a fresh sample of the non-aqueous test coolant from the same lot for each test. The entire container and aerator tube (see 6.1 and 6.4) shall be cleaned scrupulously prior to the first test and between each subsequent test. The same container and aerator tube shall be used in all of the tests. The container shall be cleaned in a cleaning bath as defined by 7.3, and the aerator tube shall be immersed first in acetone and flushed back and forth, and then in water, and flushed back and forth using vacuum and air pressure. The entire assembly shall be thoroughly rinsed with Type II water and then dried before each test.

NOTE 2—Scrupulous cleaning of the glassware, aerator tube, and diffuser stone before the initial test and between tests will reduce the potential carryover of antifoam or other contaminants from previous tests that can interfere with test reproducibility.

10. Procedure

10.1 Heat 145 mL of the non-aqueous test coolant to 88 °C in the container positioned in the temperature bath. Immerse the aerator tube and read the level of the liquid to the nearest 5 mL. Measure the temperature with the temperature measuring instrument inside the graduated container.

10.2 Connect air supply, position stopcock to permit air flow to aerator tube, and adjust the air flow rate of 1000 mL/min using a manometer or other suitable instrument for accurately measuring volumes of air flow.

10.3 The timing of the 5-min aeration period shall start at the appearance of the first bubbles in the test coolant.

10.4 At the end of 5 min, measure the volume of foam at the highest level and subtract the initial volume read after inserting the aerator tube. Read the foam volume to the nearest 5-mL graduation.

10.5 Relieve the air pressure by positioning the three-way stopcock to shut off the air supply and vent the inlet tube to the atmosphere simultaneously and record precisely (±0.2 s) the time for the foam to collapse to the first appearance of an "eye" on the surface of the test coolant.

11. Recording of Data

11.1 The testing shall be done in triplicate using new non-aqueous test coolant for each test run. The data shall be recorded as the tests progress in the format of Table 1. If the glassware is clean at the beginning of each run, that is, free of residual defoamer, there should be no discernible uptrend in the data recorded as the tests progress. If there is a discernible uptrend in either the foam volume or the break time, clean the apparatus as previously described and perform a fourth test.

12. Averaging the Results and Presentation

12.1 If the test consists of three iterations, average the three results. If the test consists of four iterations, average the last two results. Present the results in a format similar to that shown in Table 1.

13. Precision and Bias

13.1 A statement on precision and bias is under review, and round robin testing is currently in progress.

14. Keywords

14.1 engine coolants; foaming; glassware; non-aqueous

TABLE 1 Test Results

Test Run	Foam Volume at 5 min, mL	"Break Time" Appearance of "Eye," s
1		
2		
3		
4 (if needed)		
Average of 3		
Average of Last Two		

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[4] Nochromix® is an inorganic oxidizer that contains no metallic ions. The white powder is dissolved in water and mixed with concentrated sulfuric acid, giving a solution that reportedly is more strongly oxidizing than chromic acid. The sole source of supply of Nochromix known to the committee at this time is Godax Laboratories Inc., PO box 422, Cabin John, MD 20818. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

ANNEX

(Mandatory Information)

A1. TEST FOR MAXIMUM PORE DIAMETER AND PERMEABILITY OF STONE DIFFUSERS (BASED ON TEST METHOD E128 AND SPECIFICATION E1)

A1.1 Definitions

A1.1.1 *maximum pore diameter, n*—diameter in micrometres of a capillary of circular cross section that is equivalent (with respect to surface tension effects) to the largest pore in the diffuser under consideration.

A1.1.2 *permeability, n*—flow of air, in millilitres per minute, through the diffuser stone at air pressure of 2.5 kPa (250 mm of water).

A1.2 Apparatus

A1.2.1 Apparatus for the maximum pore diameter determination consists of a regulated source of clean, dry, compressed air; a U-tube water manometer of sufficient length to read a pressure differential of 800 mm; and a cylinder of a size sufficient (250 mL is suitable) to immerse easily a diffuser stone to a depth of 100 mm.

A1.2.2 Additional apparatus for permeability determination consists of a gas volume meter of sufficient capacity to measure flow rates of at least 6000 mL/min and a filtering flask large enough that 25.4-mm diameter diffuser stones will pass through the neck. The flask shall be fitted with a rubber stopper with a single hole to admit the air-inlet tube (see Fig. A1.1).

A1.3 Procedure

A1.3.1 *Maximum Pore Diameter*—Support the clean diffuser by an air-inlet tube at a depth of 100 mm as measured to the top of the stone in distilled water in a cylinder and allow it to soak for at least 2 min. Connect the air-inlet tube to a controllable source of clean, compressed air and a manometer as shown in Fig. A1.2. Increase the air pressure at a rate of about 50 mm of water/min until the first dynamic bubble passes through the filter and rises through the water. The first dynamic bubble is recognized by being followed by a succession of additional bubbles. Read the water level in both legs of the manometer and record the difference as the pressure, p. The uniformity of the distribution of pores approaching maximum pore size may be observed by gradually increasing the air pressure and noting the uniformity with which streams of bubbles are distributed over the surface.

A1.3.1.1 Calculate maximum pore diameter, D, in micrometres, as follows:

$$D = 29\,225/(p - 100) \quad \text{(A1.1)}$$

A1.3.2 *Permeability*—Connect the clean, dry diffuser stone to a controllable source of clean, dry, compressed air and place it in a filtering flask connected to a suitable flowmeter as shown in Fig. A1.1. Adjust the pressure differential to 2.5 kPa (250 mm of water) and measure the rate of flow of air through the diffuser stone in millilitres per minute. Depending on the sensitivity of the flowmeter used, this observation may be made for a suitably longer period than the average flow rate per minute recorded.

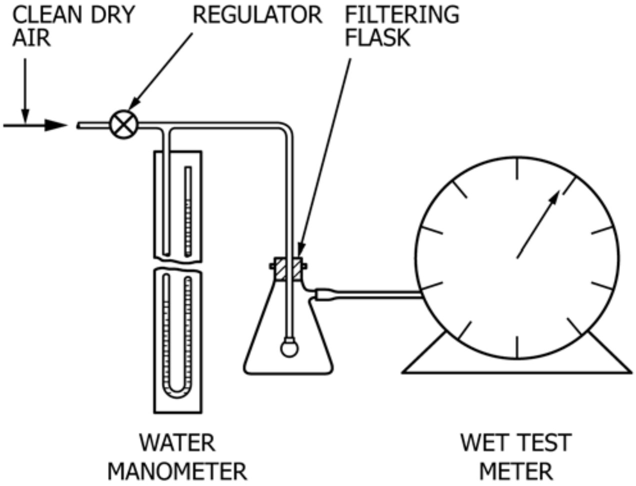

FIG. A1.1 Apparatus for Measuring Permeability

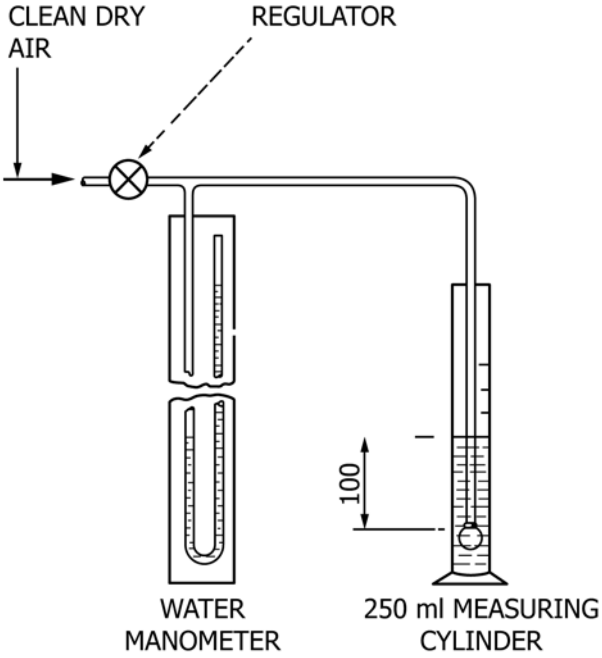

FIG. A1.2 Apparatus for Measuring Maximum Pore Size

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