Designation: E1719 – 24

Standard Test Method for Vapor Pressure of Liquids by Ebulliometry[1]

This standard is issued under the fixed designation E1719; 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 describes procedures for determination of the vapor pressure of liquids by ebulliometry (boiling point measurements). It applies to pure liquids and azeotropes with an atmospheric boiling point between 285 K and 575 K, which can be condensed completely and returned to the ebulliometer boiler, that is, all materials must be condensable at total reflux. Liquid mixtures may be studied if they do not contain non-condensable components. Liquid mixtures that contain trace amounts of volatile but completely condensable components may also be studied, but they will produce vapor pressure data of greater uncertainty. Boiling point temperatures are measured at applied pressures of 1.0 kPa to 100 kPa (7.5 torr to 760 torr).

1.2 SI units are 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Section 8.

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

D2879 Test Method for Vapor Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope

E1 Specification for ASTM Liquid-in-Glass Thermometers

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E1142 Terminology Relating to Thermophysical Properties

E1194 Test Method for Vapor Pressure

E1970 Practice for Statistical Treatment of Thermoanalytical Data

3. Terminology

3.1 *Definitions:*

3.1.1 The following terms apply to this test method and can be found in Terminology E1142; *boiling temperature* and *vapor pressure*.

3.1.2 For definitions of other terms used in this test method, refer to Terminology E1142.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *ebulliometer*—a one-stage, total-reflux boiler designed to minimize superheating of the boiling liquid.

3.2.2 *manostat*—a device for maintaining constant vacuum or pressure.

3.2.3 *superheating*—act of heating a liquid above the equilibrium boiling temperature for a particular applied pressure.

3.3 *Symbols:*

A, B, C = Antoine vapor pressure equation constants ($\log_{10}$, kPa, K) for the Antoine vapor pressure equation: $\log_{10} P = A - B/(T + C)$,

P = vapor pressure, kPa, and

T = absolute temperature, K.

4. Summary of Test Method

4.1 A specimen is charged to the ebulliometer boiler. The ebulliometer is connected to a manostat, and coolant is circulated through the ebulliometer condenser. The manostat is set at a low pressure, and the specimen is heated to the boiling temperature. The boiling temperature and manostat pressure are recorded upon reaching a steady-state, and the manostat pressure is raised to a higher value. A suitable number (usually five or more) of boiling temperature points are recorded at

[1] This test method is under the jurisdiction of ASTM Committee E37 on Thermal Measurements and is the direct responsibility of Subcommittee E37.01 on Calorimetry and Mass Loss.

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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.

successively higher controlled pressures. The pressure-temperature data are fitted to the Antoine vapor pressure equation. Vapor pressure values required for specific reports are computed from the derived equation.

4.2 The capability of the entire apparatus (ebulliometer, thermometer, manostat, etc.) is checked periodically by the procedure described in Annex A1. This procedure consists of measuring the boiling temperature data for a pure reference substance such as water and comparing the derived vapor pressure data to the known reference values.

5. Significance and Use

5.1 Vapor pressure is a fundamental thermodynamic property of a liquid. Vapor pressure and boiling temperature data are required for safety data sheets (SDS), the estimation of volatile organic compounds (VOC), and other needs related to product safety. Vapor pressures are important for prediction of the transport of a chemical in the environment; see Test Method E1194.

6. Interferences

6.1 This test method is limited to thermally stable materials over the measurement temperature range. Boiling temperatures that drift monotonically (not cyclically) up or down and specimen discoloration and smoking are indications of thermal instability due to decomposition or polymerization. See Test Method D2879 (9.3 and Note 8 therein). Vapor pressure data may be measured below the initial decomposition or polymerization temperature; see 9.7 and 10.2.

6.2 The test method is limited to materials that boil smoothly under the operation conditions of the ebulliometer. Materials that "bump" continually, boil erratically, or eject material through the condenser are unsuitable for study by this test method.

7. Apparatus

7.1 *Ebulliometer*[3]—A vapor-lift-pump, stirred-flask, or equivalent type of ebulliometer.

7.1.1 *For Example, a Vapor-Lift-Pump Ebulliometer*[4]—Fig. 1 shows the dimensions for an example twin-arm ebulliometer, a one-stage, total-reflux boiler equipped with a vapor-lift pump to spray slugs of equilibrated liquid and vapor on a thermometer well. The boiler (*e*), constructed from concentric pieces of 200 mm glass tubing (5 mm and 10 mm outside diameter), has powdered glass fused to the heated surface to promote smooth boiling. The boiler is wrapped with an electrical heater. Twin vapor-lift pumps (d-constructed of 270 mm lengths of 5 mm outside diameter glass tubing) spray liquid and vapor slugs on a 100 mm thermometer well (*c*) wrapped with a glass spiral to promote thermal equilibration. The vapor-lift pumps dissipate the effects of superheating. The ebulliometer is connected to the manostat through a 200 mm reflux condenser (*b*); see 7.3. The side view in Fig. 1 shows a septum port and stopcock (*f* and *i*) where materials may be charged to the apparatus. Except for the condenser, septum port, and stopcock, the entire ebulliometer is insulated with a suitable case or wrapping. A window should be left to observe the smoothness of boiling and the return rate (drop rate) of condensed vapor into the 125 mL boiler return reservoir.

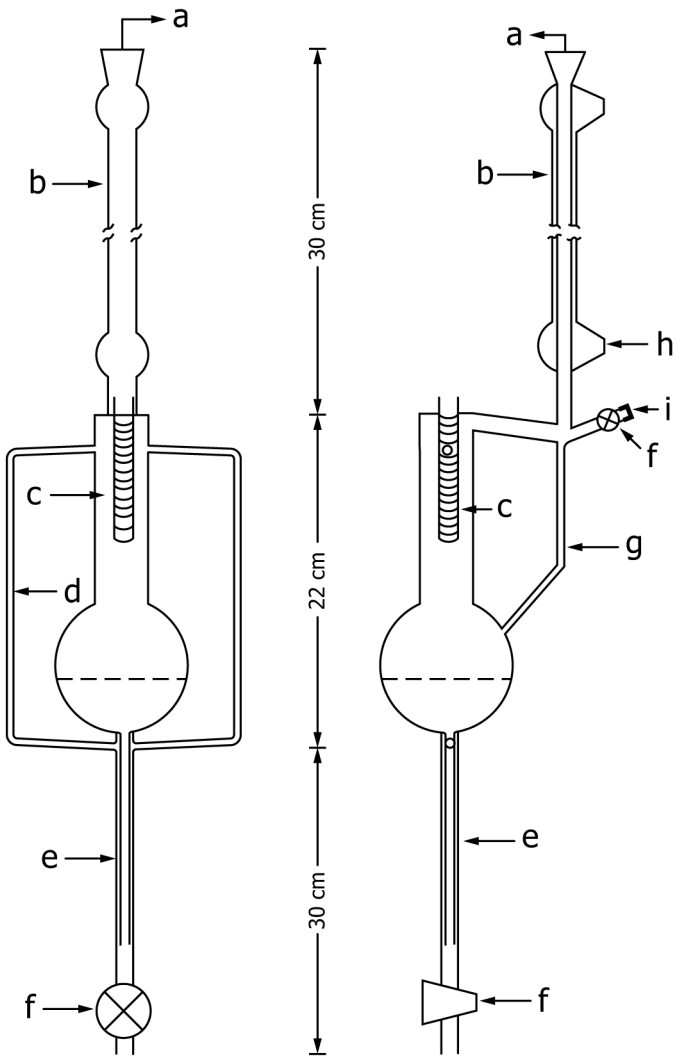

FIG. 1 Vapor-Lift-Pump Ebulliometer

7.1.1.1 For example, a Swietoslawski-type ebulliometer[5] may be used instead.

7.1.2 For example, *a Stirred-Flask Ebulliometer*, Fig. 2 shows an example of a stirred-flask ebulliometer, which is a one-stage, total-reflux boiler equipped with a magnetic stirrer to circulate the boiling liquid past a thermometer well which is immersed in the liquid. The boiler is a 250 mL, round-bottomed, single-neck boiling flask modified with a 7 mm inside diameter thermometer well positioned diagonally toward the bottom of the flask. The bottom half of the boiler has powdered glass fused to the inner surface to promote smooth

[3] An ebulliometer can be assembled from readily available lab glassware.

[4] Olson, J. D., *Journal of Chemical Engineering Data*, Vol 26, 1981, pp. 58–64.

[5] Malanowski, S., "Experimental Methods for Vapour-Liquid Equilibria. Part 1. Circulation Methods," *Fluid Phase Equilibria*, Vol 8, No. 2, 1982, pp. 197–219.