Designation: E1782 – 22

Standard Test Method for Determining Vapor Pressure by Thermal Analysis[1]

This standard is issued under the fixed designation E1782; 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 a procedure for the determination of the vapor pressure of pure liquids or melts from boiling point measurements made using differential thermal analysis (DTA) or differential scanning calorimetry (DSC) instrumentation operated at different applied pressures.

1.2 This test method can be used for the temperature range 273 K to 773 K (0 °C to 500 °C) and for pressures between 0.2 kPa to 2 MPa. These ranges may differ depending upon the instrumentation used and the thermal stability of materials tested. Because a range of applied pressures is required by this test method, the analyst is best served by use of instrumentation referred to as high pressure differential thermal instrumentation (HPDSC or HPDTA).

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard. (See also IEEE/ASTM SI 10.)

1.4 *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.*

1.5 *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]

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

E473 Terminology Relating to Thermal Analysis and Rheology

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

E967 Test Method for Temperature Calibration of Differential Scanning Calorimeters and Differential Thermal Analyzers

E1142 Terminology Relating to Thermophysical Properties

E2071 Practice for Calculating Heat of Vaporization or Sublimation from Vapor Pressure Data

E3142 Test Method for Thermal Lag of Thermal Analysis Apparatus

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI) The Modern Metric System

3. Terminology

3.1 *Definitions:*

3.1.1 The following terms are applicable to this test method and can be found in either Terminology E473 or Terminology E1142: *boiling pressure, boiling temperature, differential scanning calorimetry (DSC), differential thermal analysis (DTA), vapor pressure, vaporization point, vaporization temperature.*

3.2 *Symbols:*

3.2.1 A, B, C—Antoine vapor pressure equation (**1**)[3] constants ($\log_{10}$, kPa, K):

$$\text{Antoine vapor pressure equation: } \text{Log}_{10} P = A - B/(T+C)$$

where:

P	=	vapor pressure, kPa,
T	=	temperature, K, and
A, B, and C	=	constants.

4. Summary of Test Method

4.1 In thermal analysis, a physical property of a material is measured either as a function of time at a specified constant temperature, or more frequently, as a function of temperature under conditions of a fixed rate of temperature change. The measured property is the dependent variable and the measured temperature is the independent variable. A specimen in an appropriate container is heated at a constant rate within a DTA or DSC instrument operated under an applied constant vacuum/

[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.

[3] The boldface numbers in parentheses refer to a list of references at the end of this standard.

pressure between 0.2 kPa and 2 MPa until a boiling endotherm is recorded. Boiling is observed at the temperature where the specimen partial pressure equals the pressure applied to the test chamber. The pressure is recorded during observation of the boiling endotherm and the boiling temperature is recorded as the extrapolated onset temperature. This measurement is repeated using new specimens for each of five or more different pressures covering the pressure range of interest. The pressure-temperature data are fitted as Log_{10} P and 1/T (K^{-1}) to the Antoine vapor pressure equation (see Fig. 1). Vapor pressure values required for specific reports are then computed from the derived equation.

4.2 The capability of the assembled system after calibration shall be periodically checked by using this test method on high purity water as a reference substance and comparing the derived vapor pressure data with the NBS/NRC steam tables attached as Appendix X1. For pressures below 5 kPa, operation of the assembled system may be checked using 1-octanol (**2**).

5. Significance and Use

5.1 Vapor pressure is a fundamental thermophysical property of a liquid. Vapor pressure data are useful in process design and control, in establishing environmental regulations for safe handling and transport, for estimation of volatile organic content (VOC), and in deriving hazard assessments.

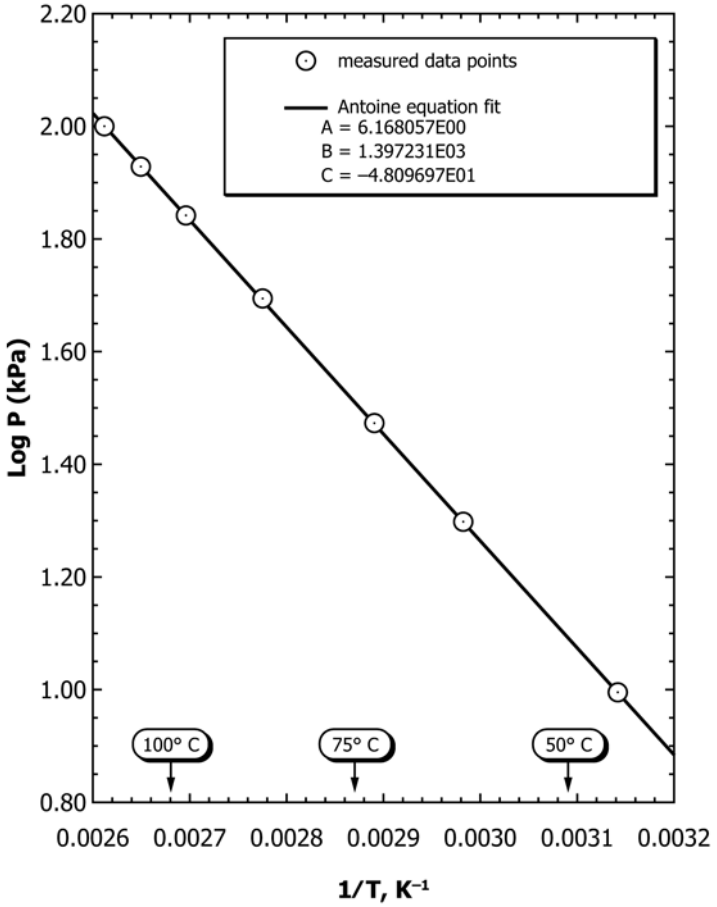
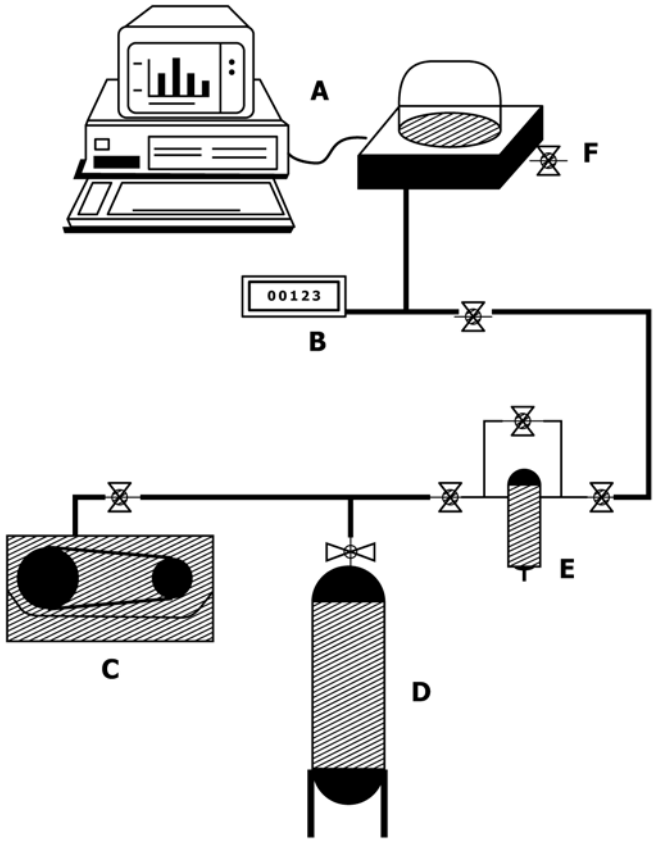


FIG. 1 Vapor Pressure Curve with Experimental Data and Antoine Equation Fit



NOTE 1—"A", DSC/DTA instrument; "B," pressure transducer; "C, "pressure/vacuum source; "D," pressure stabilizer; "E," pressure regulator; and "F," relief valve.

FIG. 2 Schematic of Apparatus

Vapor pressure and boiling temperature data are required for Safety Data Sheets (SDS). The enthalpy of vaporization may also be estimated from the slope of the vapor pressure curve (see Practice E2071).

6. Interferences

6.1 This test method involves the continuous monitoring of the specimen temperature within the test chamber's enclosed environment of a flowing, static, or self-generated gaseous atmosphere (or vacuum) during execution of the stipulated procedure. In DSC and DTA apparatus, the temperature sensor utilized to measure the specimen temperature is not in direct contact with the specimen but is in fixed close thermal contact assumed to be representative of the specimen, such that the measured temperature is that of the temperature sensor itself and the actual specimen temperature will lag behind this measured temperature during heating or cooling. The magnitude of this temperature offset depends upon a number of systematic and random factors including but not limited to type and size of sensor, rate of temperature change, size and thermal conductance of the specimen, specimen container, and temperature sensor, and the interfacial contact resistances between the temperature sensor and the specimen container and between the specimen and the specimen container during the measurement. To obtain the correct specimen temperature, the DSC or DTA apparatus must be temperature calibrated at