



Designation: E 1782 – 03

Standard Test Method for Determining Vapor Pressure by Thermal Analysis¹

This standard is issued under the fixed designation E 1782; 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 may be used for the temperature range 273 to 773 K (0 to 500 °C) and for pressures between 5 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 Computer or electronic-based instruments, techniques, or data treatment equivalent to this test method may also be used.

NOTE 1—Users of this test method are expressly advised that all such instruments or techniques may not be equivalent. It is the responsibility of the user of this test method to determine the necessary equivalency prior to use. Only the manual procedures are to be considered valid.

1.4 SI value units are the standard. The customary units given in parentheses are for information only.

1.5 There is no ISO standard equivalent to this test method.

1.6 *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.*

2. Referenced Documents

2.1 ASTM Standards:

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods²

E 473 Terminology Relating to Thermal Analysis²

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method²

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 Test Methods and Recommended Practices.

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² Annual Book of ASTM Standards, Vol 14.02.

E 967 Practice for Temperature Calibration of Differential Scanning Calorimeters/Differential Thermal Analyzers²

E 1142 Terminology Relating to Thermophysical Properties²

E 2071 Practice for Calculating Heat of Vaporization or Sublimation from Vapor Pressure Data²

SI 10 Standard for Use of the International System of Units (SI) The Modern Metric System³

3. Terminology

3.1 Definitions:

3.1.1 The following terms are applicable to this test method and can be found in either Terminology **E 473** or Terminology **E 1142**: *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**)⁴ constants (log₁₀, kPa, K):

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

where:

P = vapor pressure, kPa, and

T = temperature, K.

4. Summary of Test Method

4.1 A specimen in an appropriate container is heated at a constant rate within a DTA or DSC instrument operated under an applied constant vacuum/pressure between 5 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 observance 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 Log₁₀ 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.

³ Annual Book of ASTM Standards, Vol 14.04.

⁴ The boldface numbers given in parentheses refer to a list of references at the end of the text.

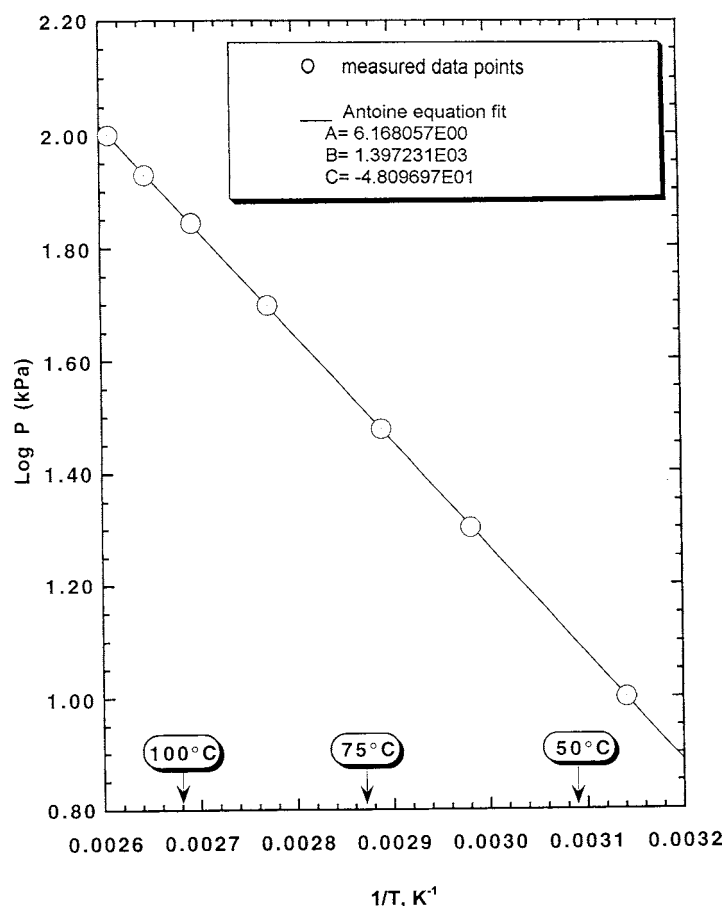


FIG. 1 Vapor Pressure Curve with Experimental Data and Antoine Equation Fit

4.2 The capability of the assembled system after calibration should be periodically checked by using this method on pure water as a reference substance and comparing the derived vapor pressure data with the NBS/NRC steam tables attached as [Appendix X1](#).

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. Vapor pressure and boiling temperature data are required for Material Safety Data Sheets (MSDS). The enthalpy of vaporization may also be estimated from the slope of the vapor pressure curve (See Practice [E 2071](#)).

6. Interferences

6.1 This test method is limited to materials that exhibit a singular sharp boiling endotherm under the conditions outlined in this test method.

6.2 Oxidation, pyrolysis, or polymerization of condensed organic materials retained at temperatures above their ambient boiling point may be encountered at the elevated pressures of this method. This will be observed as an exotherm or a significantly broadened endotherm, or both, and shall not be

considered a valid pressure-temperature datum point. Use of an inert gas for elevated pressures or for back-filling after evacuation of the sample chamber is recommended to minimize the risk of oxidation.

6.3 Partial blockage of the pinhole in the DSC containers could occasionally be encountered. This may be observed as noise spikes on the boiling endotherm and shall not be considered a valid pressure-temperature datum point.

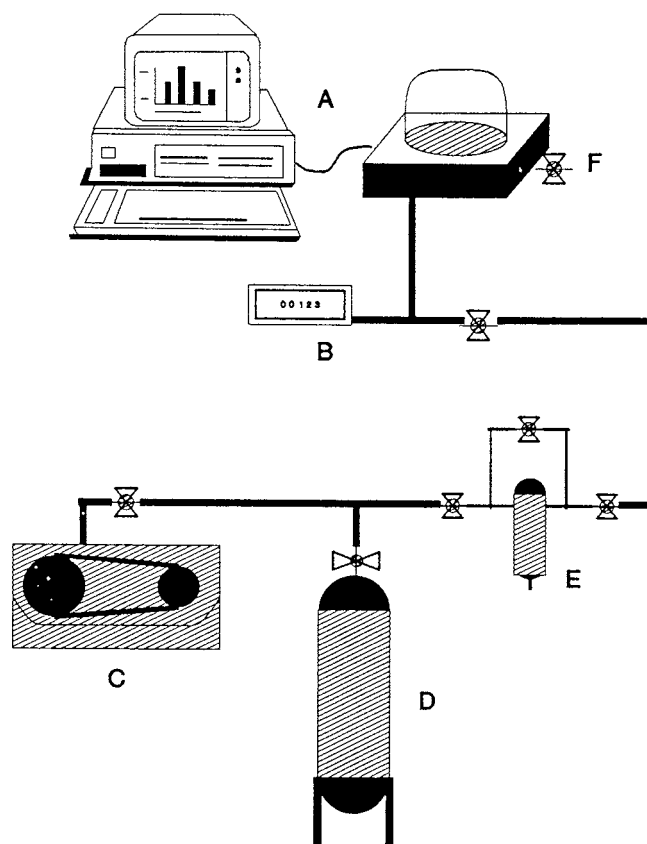
7. Apparatus

7.1 The essential equipment required to provide the minimum instrument capability of this test method includes (see [Fig. 2](#)):

7.1.1 *Differential Scanning Calorimeter (DSC) or Differential Thermal Analyzer (DTA)*, consisting of:

7.1.1.1 *DSC/DTA Test Chamber*, composed of a furnace(s) to provide uniform controlled heating of a specimen and reference at a constant rate within the 273 to 773 K temperature range of this test method; a temperature sensor to provide an indication of the specimen/furnace temperature to ± 1 K; a differential sensor to detect a difference (temperature or heat flow) between the specimen and reference equivalent to 5 mW; and a means of sustaining an inert gas or vacuum test chamber environment at pressures above and below ambient.

7.1.1.2 *Temperature Controller*, capable of executing a specific temperature program by operating the furnace(s)



NOTE—"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