



Standard Practice for Calculating Heat of Vaporization or Sublimation from Vapor Pressure Data¹

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1. Scope

1.1 This practice describes the calculation of the heat of vaporization of a liquid or the heat of sublimation of a solid from measured vapor pressure data. It is applicable to pure liquids, azeotropes, pure solids, and homogenous solid solutions over the temperature range for which the vapor pressure equation fitted to the measured data is applicable.

NOTE 1—This practice is generally not applicable to liquid mixtures. For a pure liquid or azeotrope, composition does not change upon vaporization so that the integral heat of vaporization is identical to the differential heat of vaporization. Non-azeotropic liquid mixtures change composition upon vaporizing. Heat of vaporization data computed from this practice for a liquid mixture are valid only as an approximation to the mixture differential heat of vaporization; it is not a valid approximation to the mixture integral heat of vaporization.

1.2 SI values are 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.*

1.4 There is no ISO standard equivalent to this practice.

2. Referenced Documents

2.1 ASTM Standards:

- D 2879 Standard Test Method for Vapor Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscopes²
- E 1142 Standard Terminology Relating to Thermophysical Properties³
- E 1194 Standard Test Method for Vapor Pressure⁴
- E 1719 Standard Test Method for Vapor Pressure of Liquids by Ebulliometry²
- E 1782 Standard Test Method for Determining Vapor Pressure by Thermal Analysis²

3. Terminology

3.1 Symbols:

3.1.1 *A, B, C*—Antoine vapor pressure equation constants ($\log_{10}$, kPa, K), Antoine vapor pressure equation:

$$\log_{10}P = A - B/(T + C)$$

3.1.2 *P*—vapor pressure, kPa.

3.1.3 *P_c*—critical pressure, kPa.

3.1.4 *P_r*—reduced pressure = P/P_c .

3.1.5 *T*—absolute temperature, K.

3.1.6 *T_c*—critical temperature, K.

3.1.7 *T_r*—reduced temperature = T/T_c .

3.1.8 *V*—molar volume, cm³/mol.

3.1.9 *R*—gas constant, 8.31433 J/mol-K; 8314330. kPa-cm³/mol-K.

3.1.10 ΔH_v —heat of vaporization, J/mol.

3.1.11 ΔZ_v —difference in compressibility factor ($Z = PV/RT$) upon vaporization. Clapeyron equation:

$$\Delta H_v = -R\Delta Z_v[d(\ln P)/d(1/T)]$$

3.1.11.1 *Discussion*—The subscript “V” will be used throughout this practice to designate the vaporization of a liquid. If the vapor pressure data were measured for a solid, substitute the subscript “S” for the sublimation of a solid.

3.2 Definitions:

3.2.1 Specialized terms used in this practice are defined in Terminology E 1142.

3.2.2 *sublimation*—transition from a solid phase to a gaseous phase.

3.2.3 *vaporization*—transition from a liquid phase to a gaseous phase.

4. Summary of Practice

4.1 Vapor pressure data are measured by other referenced ASTM Standards and then correlated with the Antoine equation. The heat of vaporization or sublimation is computed at the desired temperature from the vapor-pressure temperature derivative from the fitted Antoine equation by use of the Clapeyron equation **(1)**⁵. In the Clapeyron equation, ΔZ_v is determined by either the Clausius-Clapeyron **(2)** approximation ($\Delta Z_v = 1$) or the Haggmacher**(3)** approximation ($\Delta Z_v = \{1 - [P_r/(T_r)^3]\}1/2$).

⁵ The boldface numbers given in parentheses refer to a list of references at the end of the text.

¹ This practice is under the jurisdiction of Committee E-37 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 05.02.

³ *Annual Book of ASTM Standards*, Vol 14.02.

⁴ *Annual Book of ASTM Standards*, Vol 11.04.