



Standard Test Method for Estimating Kinetic Parameters by Differential Scanning Calorimeter Using the Borchardt and Daniels Method¹

This standard is issued under the fixed designation E2041; 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.

^{ε1} NOTE—Warning statements were editorially corrected throughout in September 2013.

1. Scope

1.1 This test method describes the determination of the kinetic parameters of activation energy, Arrhenius pre-exponential factor, and reaction order using the Borchardt and Daniels² treatment of data obtained by differential scanning calorimetry. This test method is applicable to the temperature range from 170 to 870 K (–100 to 600°C).

1.2 This treatment is applicable only to smooth exothermic reactions with no shoulders, discontinuous changes, or shifts in baseline. It is applicable only to reactions with reaction order $n \leq 2$. It is not applicable to acceleratory reactions and, therefore, is not applicable to the determination of kinetic parameters for most thermoset curing reactions or to crystallization reactions.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 This test method is similar, but not equivalent to, ISO 11357, Part 5, that contains provisions for additional information not supplied by this test method.

1.5 *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:³

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

Current edition approved Sept. 15, 2013. Published September 2013. Originally approved in 1999. Last previous edition approved in 2008 as E2041 – 08^{ε1}. DOI: 10.1520/E2041-13E01.

² Borchardt, H.J., Daniels, F., *Journal of the American Chemical Society*, Vol 79, 1957, pp. 41–46.

³ 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.

E473 Terminology Relating to Thermal Analysis and Rheology

E537 Test Method for The Thermal Stability of Chemicals by Differential Scanning Calorimetry

E698 Test Method for Arrhenius Kinetic Constants for Thermally Unstable Materials Using Differential Scanning Calorimetry and the Flynn/Wall/Ozawa Method

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

E968 Practice for Heat Flow Calibration of Differential Scanning Calorimeters

E1142 Terminology Relating to Thermophysical Properties

E1445 Terminology Relating to Hazard Potential of Chemicals

E1641 Test Method for Decomposition Kinetics by Thermogravimetry Using the Ozawa/Flynn/Wall Method

E1970 Practice for Statistical Treatment of Thermoanalytical Data

2.2 ISO Standards:⁴

ISO 11357 Part 5: Determination of Temperature and/or Time of Reaction and Reaction Kinetics

3. Terminology

3.1 *Definitions*—Specific technical terms used in this test method are defined in Terminologies E473, E1142, and E1445, including *calibration*, *calorimeter*, *differential scanning calorimetry*, *enthalpy*, *peak*, *reaction*, *repeatability*, *reproducibility*, and *slope*.

4. Summary of Test Method

4.1 A test specimen is heated at a linear rate in a differential scanning calorimeter or other suitable calorimeter through a region of exothermic reaction behavior. The rate of heat evolution, developed by a chemical reaction, is proportional to the rate of reaction. Integration of the heat flow as a function of time yields the total heat of a reaction.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.