



Standard Test Method for Thermal Conductivity of Liquids¹

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1. Scope

1.1 This test method covers the determination of the thermal conductivity of nonmetallic liquids. It is applicable to liquids that are: (1) chemically compatible with borosilicate glass and platinum; (2) moderately transparent or absorbent to infrared radiation; and (3) have a vapor pressure less than 200 torr at the temperature of test.

1.1.1 Materials that have vapor pressures of up to 345 kPa (50 psia), absolute can be tested provided that adequate measures are taken to repress volatilization of the sample by pressurizing the thermal conductivity cell. The usual safety precautions for pressure vessels shall be followed under these circumstances.

1.2 The values stated in SI units are to be regarded as the standard. The values in parentheses are for information only.

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.*

2. Referenced Documents

2.1 ASTM Standards:

- D 86 Test Method for Distillation of Petroleum Products²
- D 1160 Test Method for Distillation of Petroleum Products at Reduced Pressures²
- D 2887 Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography³
- D 2893 Test Method for Oxidation Characteristics of Extreme-Pressure Lubricating Oils³

3. Terminology

3.1 Units:

3.1.1 The energy units used in this test method are defined as follows:

1 Cal (International Table calorie) = 4.1868 absolute J

1 Btu (British thermal unit) = 1055.07 absolute J

3.1.2 The units of thermal conductivity commonly used and their inter-conversion factors are shown in Table 1.

TABLE 1 Selected Conversion Factors for Thermal Conductivity

To Convert From	To	Multiply By
cal/s·cm·°C	w/cm·°C	4.184
cal/s·cm·°C	kcal/h·m·°C	360
cal/s·cm·°C	Btu·in./h·ft ² ·°F	2903
w/cm·°C	cal/s·cm·°C	0.2389
w/cm·°C	kcal/h·m·°C	86.00
w/cm·°C	Btu·in./h·ft ² ·°F	693.7
kcal/h·m·°C	cal/s·cm·°C	0.002778
kcal/h·m·°C	W/cm·°C	0.01163
kcal/h·m·°C	Btu·in./h·ft ² ·°F	8.064
Btu·in./h·ft ² ·°F	cal/s·cm·°C	0.0003445
Btu·in./h·ft ² ·°F	W/cm·°C	0.001442
Btu·in./h·ft ² ·°F	kcal/h·m·°C	0.1240

3.2 For working purposes in this test method, the rounded-off value of 4.19 J/cal is used, as this is adequate for the precision of the test and also represents the rounded-off value of watt-second per calorie units in Table 1, thus avoiding the difficulty caused by the dual definition of the calorie.

3.3 Symbols: Symbols:

- T_f = filament temperature, °C,
- T_b = bath thermostat temperature, °C,
- ΔT = $T_f - T_b$, °C,
- r_f = filament radius, cm,
- r_i = internal radius of tube, cm,
- r_o = external radius of tube, cm,
- L = effective length of tube, cm,
- R = resistance of filament, Ω,
- I = electric current through filament, A,
- K_L = thermal conductivity of liquid, cal/s·cm·°C,
- K_G = thermal conductivity of glass-tube, cal/s·cm·°C,
- A = $[\ln(r_o/r_f)]/2\pi L$, cm⁻¹, and
- B = $[\ln(r_o/r_i)]/2\pi L K_G$, s·°C/cal.

4. Summary of Test Method

4.1 A thermal conductivity cell consisting of a straight, four-lead, platinum resistance thermometer element located concentrically in a long, small-diameter, precision-bore borosilicate glass tube is calibrated by accurate measurement of the cell dimensions and by determination of the temperature-resistance properties of the platinum element.

4.2 Thermal conductivity is determined by measurement of the temperature gradient produced across the liquid sample by a known amount of energy introduced into the cell by electrically heating the platinum element.

¹ This test method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.11 on Engineering Science and High Performance Fluids and Solids.

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² Annual Book of ASTM Standards, Vol 05.01.

³ Annual Book of ASTM Standards, Vol 05.02.