



Standard Test Method for Low Temperature, Low Shear Rate, Viscosity/Temperature Dependence of Lubricating Oils Using a Temperature- Scanning Technique¹

This standard is issued under the fixed designation D 5133; 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 was developed to measure the apparent viscosity of engine oil at low temperatures.

1.2 A shear rate of approximately 0.2 s^{-1} is produced at shear stresses below 100 Pa. Apparent viscosity is measured continuously as the sample is cooled at a rate of 1°C/h over the range -5 to -40°C , or to the temperature at which the viscosity exceeds 40 000 mPa·s (cP).

1.3 The measurements resulting from this test method are viscosity, the maximum rate of viscosity increase (Gelation Index) and the temperature at which the Gelation Index occurs.

1.4 Applicability to petroleum products other than engine oils has not been determined in preparing 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.*

1.6 All terms in this test method are in SI units.

2. Referenced Documents

2.1 ASTM Standards:

D 341 Test Method for Viscosity-Temperature Charts for Liquid Petroleum Products²

D 3829 Test Method for Predicting the Borderline Pumping Temperature of Engine Oils³

D 4684 Test Method for Determination of Yield Stress and Apparent Viscosity of Engine Oils at Low Temperature³

3. Terminology

3.1 Definitions:

3.1.1 *apparent viscosity, n*—the viscosity obtained by use of this test method.

3.1.1.1 *Discussion*—See 3.1.6 for definition of viscosity and units.

3.1.2 *Newtonian oil, n*—an oil that, at a given temperature, exhibits a constant viscosity at all shear rates or shear stresses.

3.1.3 *non-Newtonian oil, n*—an oil that, at a given temperature, exhibits a viscosity that varies with shear stress or shear rate.

3.1.4 *shear rate, n*—velocity gradient perpendicular to the direction of flow.

3.1.4.1 *Discussion*—The SI unit for shear rate is the reciprocal second (1/s; also s^{-1}).

3.1.5 *shear stress, n*—force per unit area in the direction of flow.

3.1.5.1 *Discussion*—The SI unit for shear stress is the Pascal (Pa).

3.1.6 *viscosity, n*—that property of a fluid which resists flow.

3.1.6.1 *Discussion*—Viscosity is defined as the ratio of the applied shear stress (force causing flow) and the shear rate (resultant velocity of flow per unit distance from a stationary surface wet by the fluid). Mathematically expressed:

$$\text{viscosity} = \text{shear stress/shear rate or, symbolically, } \eta = \tau/G \quad (1)$$

in which the symbols in the second portion of Eq 1 are defined by the terms in the first portion of the equation. The SI unit for viscosity used herein is milliPascal seconds (mPa·s).

3.2 Definitions of Terms Specific to This Test Method:⁴

3.2.1 *air-binding oils*—those engine oils whose borderline pumping temperatures are determined by a combination of gelation and viscous flow.

3.2.2 *borderline pumping temperature, n*—that temperature at which an engine oil may have such poor flow characteristics that the engine oil pump may not be capable of supplying sufficient lubricant to the engine.

3.2.3 *calibration oil, n*—Newtonian oils developed and used to calibrate the viscometer drive module over the viscosity range required for this test method.

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.070C on Low-Temperature Rheology of Non-Newtonian Fluids.

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² *Annual Book of ASTM Standards*, Vol. 05.01.

³ *Annual Book of ASTM Standards*, Vol. 05.02.

⁴ Equipment and materials for this method are available from Tannas Co., 4800 James Savage Rd., Midland, MI 48642.