



Standard Test Methods for Viscosity of Materials by a Falling Needle Viscometer¹

This standard is issued under the fixed designation D5478; 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 These test methods cover the measurement of the viscosity of Newtonian and non-Newtonian liquids. These test methods are applicable to liquids having viscosities in the range from 5×10^{-4} to 10^3 Pa·s (0.5 to 10^6 cP). The shear rate range is dependent upon the needle used and viscosity of the liquid and may vary from 10^{-4} to 10^3 s⁻¹. With an extension bar and applied weight, a shear rate of 10^4 s⁻¹ may be achieved.

1.2 The yield stress of liquids having this property may also be determined.

1.3 These test methods consist of determining liquid viscosities of Newtonian and non-Newtonian fluids (clear or opaque) by measuring the steady-state (constant) or terminal velocities of cylindrical needles as they fall through the test liquid under the influence of gravity. Yield stresses of non-Newtonian liquids may be measured using the same procedure.

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

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:²

E1 Specification for ASTM Liquid-in-Glass Thermometers
E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

3. Terminology

3.1 Definitions:

¹ These test methods are under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and are the direct responsibility of Subcommittee D01.24 on Physical Properties of Liquid Paints and Paint Materials.

Current edition approved Feb. 1, 2013. Published February 2013. Originally approved in 1993. Last previous edition approved in 2009 as published as D5478 – 09. DOI: 10.1520/D5478-13.

² 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.

3.1.1 *dilatant or shear thickening fluid, n*—fluid in which the apparent viscosity increases with increasing shear rate.

3.1.2 *Newtonian fluid, n*—fluid in which the dynamic viscosity does not vary with shear rate but only with the temperature and pressure.

3.1.3 *Non-Newtonian fluid, n*—fluid in which the dynamic viscosity varies with shear rate over at least some shear rate range.

3.1.3.1 *Discussion*—This viscosity is sometimes referred to as the “apparent viscosity” since it is not a true property of the fluid but a variable depending on the shear rate. The viscosity of most non-Newtonian fluids fits a power law expression. A power law fluid is defined by the following equation:

$$\eta_a = K(dy/dt)^{n-1} \quad (1)$$

where:

η_a = apparent viscosity, Pa·s (or dyne·s/cm² = P), mPa·s = cP,
 K = fluid consistency, Pa·sⁿ (or dyne·sⁿ/cm²),
 dy/dt = shear rate or velocity gradient, 1/s, and
 n = flow behavior index, dimensionless.

3.1.4 *pseudoplastic or shear thinning fluid, n*—fluid in which the apparent viscosity decreases with increasing shear rate.

3.1.5 *viscosity, n*—the ratio between an applied shear stress to the resulting shear rate (velocity gradient) is defined as the dynamic viscosity. It is a measure of the resistance to flow of a fluid.

3.1.5.1 *Discussion*—In the SI unit system, the units of viscosity are Pa·s. One mPa·s is equal to one centipoise (cP).

3.1.6 *yield stress, n*—some fluids when subjected to a shear stress behave as deformable solids until a certain critical shear stress (yield stress or yield value) is reached after which they behave as fluids.

3.1.6.1 *Discussion*—Examples of such fluids include many paints and pigment pastes and certain food materials such as ketchup.

4. Summary of Test Methods

4.1 Test Method A consists of determining the viscosity of Newtonian liquids.

*A Summary of Changes section appears at the end of this standard