



Standard Test Method for Predicting the Borderline Pumping Temperature of Engine Oil¹

This standard is issued under the fixed designation D 3829; 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 covers the prediction of the borderline pumping temperature (BPT) of engine oils through the use of a 16-h cooling cycle over the temperature range from 0 to -40°C.

1.2 Applicability to petroleum products other than engine oils has not been determined.

1.3 This test method uses the millipascal (mPa·s), as the unit of viscosity. For information, the equivalent centipoise unit is shown in parentheses.

1.4 *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. Terminology

2.1 Definitions:

2.1.1 *apparent viscosity*—the determined viscosity obtained by use of this test method.

2.1.2 *Newtonian oil or fluid*—an oil or fluid that at a given temperature exhibits a constant viscosity at all shear rates or shear stresses.

2.1.3 *non-Newtonian oil or fluid*—an oil or fluid that at a given temperature exhibits a viscosity that varies with changing shear stress or shear rate.

2.1.4 *shear rate*—the velocity gradient in fluid flow. For a Newtonian fluid in a concentric cylinder rotary viscometer in which the shear stress is measured at the inner cylinder surface (such as the apparatus being described), and ignoring any end effects, the shear rate is given as follows:

$$G_r = \frac{2\Omega R_s^2}{(R_s^2 - R_r^2)} \quad (1)$$

$$G_r = \frac{4\pi R_s^2}{t(R_s^2 - R_r^2)} \quad (2)$$

where:

G_r = shear rate at the surface of the rotor in reciprocal seconds, s^{-1} ,

Ω = angular velocity, rad/s,

R_s = stator radius, mm,

R_r = rotor radius, mm, and

t = time in seconds for one revolution of the rotor.

For the specific apparatus being described in 5.1.1,

$$G_r = \frac{63}{t} \quad (3)$$

2.1.5 *shear stress*—the motivating force per unit area for fluid flow. Area is the area under shear. For the rotary viscometer being described, the rotor surface is the area under shear.

$$T_r = 9.81M(R_o + R_t) \times 10^{-6} \quad (4)$$

$$S_r = \frac{T_r}{2\pi R_r^2 h} \times 10^9 \quad (5)$$

where:

T_r = torque applied to rotor, N·m,

M = applied mass, g,

R_o = radius of the shaft, mm,

R_t = radius of the thread, mm,

S_r = shear stress at the rotor surface, Pa, and

h = height of the rotor, mm.

For the dimensions given in 5.1.1,

$$T_r = 31.7M \times 10^{-6} \quad (6)$$

$$S_r = 3.5M \quad (7)$$

2.1.6 *viscosity*—the ratio between the applied shear stress and rate of shear. It is sometimes called the coefficient of dynamic viscosity. This value is thus a measure of the resistance to flow of the liquid. The SI unit of viscosity is the pascal second (Pa·s). The centipoise (cP) is one millipascal second (mPa·s) and is often used.

2.2 Definitions of Terms Specific to This Standard:

2.2.1 *borderline pumping temperature*—the maximum temperature at which the critical yield stress or critical viscosity occurs, whichever is the higher temperature.

2.2.2 *calibration oils*—those oils for establishing the instrument's reference framework of apparent viscosity versus speed from which the apparent viscosities of test oils are determined.

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.07.0C on Low Temperature Rheology of Non-Newtonian Fluids.

Current edition approved Nov. 10, 2002. Published January 2003. Originally approved in 1979. Last previous edition approved in 1998 as D 3829-93(1998).