



Designation: D 6616 – 01

An American National Standard

Standard Test Method for Measuring Viscosity at High Shear Rate by Tapered Bearing Simulator Viscometer At 100°C¹

This standard is issued under the fixed designation D 6616; 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 laboratory determination of the viscosity of engine oils at 100°C and $1 \cdot 10^6 \text{ s}^{-1}$ using the Tapered Bearing Simulator (TBS) viscometer.²

NOTE 1—This test method is similar to Test Method D 4683 which uses the same TBS viscometer to measure high shear viscosity at 150°C.

1.2 The Newtonian calibration oils used to establish this test method range from approximately 5 to 12 mPa·s (cP) at 100°C and either the manual or automated protocol was used by each participant in developing the precision statement. The viscosity range of the test method at this temperature is from 1 mPa·s (cP) to above 25 mPa·s (cP), depending on the model of TBS.

1.3 The non-Newtonian reference oil used to establish the shear rate of $1 \cdot 10^6 \text{ s}^{-1}$ for this test method has a viscosity of approximately 10 mPa·s at 100°C.

1.4 Application to petroleum products other than engine oil has not been determined in preparing the viscometric information for this test method.

1.5 This test method uses the milliPascal second (mPa·s) as the unit of viscosity. This unit is equivalent to the centiPoise (cP), which is shown in parentheses.

1.6 *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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 4683 Test Method for Measuring Viscosity at High Shear Rate and High Temperature by Tapered Bearing Simulator³

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

Current edition approved Feb. 10, 2001. Published August 2001.

² Available from Tannas Co., 4800 James Savage Rd., Midland, MI 48642. This viscometer and associated equipment as listed in the research report was used to develop the precision statement. To date, no other equipment has demonstrated, through ASTM interlaboratory testing, the ability to meet the precision of this test. This is not an endorsement or certification by ASTM.

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

3. Terminology

3.1 Definitions:

3.1.1 *density*—the mass per unit volume. In the SI, the unit of density is the kilogram per cubic metre, but for practical use, a submultiple is more convenient. The gram per cubic centimetre is equivalent to 10^3 kg/m^3 and is customarily used.

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

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

3.1.4 *shear rate*—the velocity gradient in fluid flow. The SI unit for shear rate is s^{-1} .

3.1.5 *shear stress*—the motivating force per unit area for fluid flow. The *area* is the area under shear.

3.1.6 *viscosity*—the ratio between the applied shear stress and the rate of shear. It is sometimes called the coefficient of dynamic viscosity. This coefficient is a measure of the resistance to flow of the liquid. In the SI, the unit of viscosity is the Pascal·second; often the milliPascal·second or its equivalent the centiPoise is found more convenient.

3.1.6.1 *apparent viscosity*—the viscosity of a non-Newtonian fluid at a given shear rate or shear stress determined by this test method.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *idling oil*²—an oxidatively stable Newtonian oil injected into the operating viscometer stator when the instrument is likely to be held for periods of time greater than 30 min and up to two weeks at 100°C. Use of this oil prevents stator deposits from additives, which may decompose after longer exposure times in the operating viscometer and permits continuous operation of the viscometer without need to shut the instrument off.

3.2.2 *Newtonian Reference Oil*²—a specially blended Newtonian oil that has the same viscosity at 100°C as the non-Newtonian reference oil of 3.2.3.

3.2.3 *non-Newtonian reference oil*²—a specially formulated non-Newtonian oil, identified as NNR-10, having a selected apparent viscosity at $1 \cdot 10^6 \text{ s}^{-1}$ shear rate. The oil is used to establish an operating gap between the rotor and stator which will produce $1 \cdot 10^6 \text{ s}^{-1}$ shear rate when the rotor height is