



Designation: D 5481 – 96 (Reapproved 2001)⁴

An American National Standard

Standard Test Method for Measuring Apparent Viscosity at High-Temperature and High-Shear Rate by Multicell Capillary Viscometer¹

This standard is issued under the fixed designation D 5481; 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.

INTRODUCTION

Several different configurations of capillary viscometers have been successfully used for measuring the viscosity of engine oils at the high shear rates and high temperatures that occur in engines. ~~See Test Method D 4624.~~ This test method covers the use of a single apparatus² at a single temperature and single shear rate to achieve greater uniformity and improved precision.

1. Scope*

1.1 This test method covers the laboratory determination of high-temperature high-shear (HTHS) viscosity of engine oils at a temperature of 150°C using a multicell capillary viscometer containing pressure, temperature, and timing instrumentation. The shear rate for this test method corresponds to an apparent shear rate at the wall of 1.4 million reciprocal seconds ($1.4 \times 10^6 \text{ s}^{-1}$).³ This shear rate has been found to decrease the discrepancy between this test method and other high-temperature high-shear test methods³ used for engine oil specifications. Viscosities are determined directly from calibrations that have been established with Newtonian oils with viscosities from 2 to 5 mPa·s at 150°C.

1.2 *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:⁴

D 4624⁸³ Test Method for Measuring Apparent Viscosity by Capillary Viscometer at High Shear Rate and High Temperature by Tapered Bearing Simulator

D 4683⁷⁴¹ Test Method for Measuring Viscosity at High Shear Rate and High Temperature by Tapered Bearing Simulator⁴

~~D 4741 Test Method for Measuring Viscosity at High Temperature and High Shear Rate by Tapered Plug Viscometer~~

3. Terminology

3.1 Definitions:

3.1.1 *apparent shear rate at the wall*—shear rate at the wall of the capillary calculated for a Newtonian fluid, as follows:

$$S_a = 4V/\pi R^3 t \quad (1)$$

where:

S_a = apparent shear rate at the wall, s^{-1} ,

V = volume, mm^3 ,

R = capillary radius, mm, and

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: ~~on High Temperature Rheology of Non-Newtonian Fluids—Flow Properties.~~

Current edition approved Apr. 10, 1996; May 1, 2004. Published June 1996; 2004. Originally published as D 5481—93; approved in 1993. Last previous edition approved in 2001 as D 5481—936 (2001).

² Manning, R. E., and Lloyd, W. A., “Multicell High Temperature High-Shear Capillary Viscometer,” SAE Paper 861562. Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

³ Girshick, F., “Non-Newtonian Fluid Dynamics in High Temperature High Shear Capillary Viscometers,” SAE Paper 922288. Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

⁴ 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, Vol 05.02, volume information, refer to the standard’s Document Summary page on the ASTM website.

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