Designation: D7109 – 22ε1

Standard Test Method for Shear Stability of Polymer-Containing Fluids Using a European Diesel Injector Apparatus at 30 Cycles and 90 Cycles[1]

This standard is issued under the fixed designation D7109; 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.

ε[1] NOTE—Editorially added Research Report RR:D02-2041 in December 2022.

1. Scope*

1.1 This test method covers the evaluation of the shear stability of polymer-containing fluids. The test method measures the viscosity loss, in mm^2/s and percent, at 100 °C of polymer-containing fluids when evaluated by a diesel injector apparatus procedure that uses European diesel injector test equipment. The viscosity loss reflects polymer degradation due to shear at the nozzle. Viscosity loss is evaluated after both 30 cycles and 90 cycles of shearing.

NOTE 1—This test method evaluates the shear stability of oils after both 30 cycles and 90 cycles of shearing. For most oils, there is a correlation between results after 30 cycles and results after 90 cycles of shearing, but this is not universal.

NOTE 2—Test Method D6278 uses essentially the same procedure with 30 cycles but without the 90 cycles portion of the test. The correlation between results from this test method at 30 cycles and results from Test Method D6278 has been established and shown in Research Report RR:D02-2041 to be equivalent.

NOTE 3—Test Method D2603 has been used for similar evaluation of shear stability; limitations are as indicated in the significance statement. No detailed attempt has been undertaken to correlate the results of this test method with those of the sonic shear test method.

NOTE 4—This test method uses test apparatus as defined in CEC L-14-A-93. This test method differs from CEC-L-14-A-93 in the period of time required for calibration.

NOTE 5—Test Method D5275 also shears oils in a diesel injector apparatus but may give different results.

NOTE 6—This test method has different calibration and operational requirements than withdrawn Test Method D3945.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific warning statements are given in Section 8.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D2603 Test Method for Sonic Shear Stability of Polymer-Containing Oils

D5275 Test Method for Fuel Injector Shear Stability Test (FISST) for Polymer Containing Fluids

D6278 Test Method for Shear Stability of Polymer Containing Fluids Using a European Diesel Injector Apparatus

D6299 Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance

D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

2.2 *Coordinated European Council (CEC) Standard:*

CEC L-14-A-93 Evaluation of the Mechanical Shear Stability of Lubricating Oils Containing Polymers[3]

3. Terminology

3.1 *Definitions:*

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.07 on Flow Properties.

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[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] Available from CEC Secretariat, Interlynk Administrative Services, Ltd., Lynk House, 17 Peckleton Lane, Desford, Leicestershire, LE9 9JU, United Kingdom.

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

3.1.1 *kinematic viscosity, n*—the ratio of the dynamic viscosity (η) to the density (ρ) of a liquid at a given temperature.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration pressure, n*—the recorded gauge pressure when calibration fluid RL233 undergoes a viscosity loss of 2.70 mm^2/s to 2.90 mm^2/s when the recorded gauge pressure is within the range of 13.0 MPa to 18.0 MPa.

3.2.2 *percent viscosity loss, n*—viscosity loss, as defined in 3.2.3, divided by the pre-sheared viscosity, and reported as a percent.

3.2.3 *viscosity loss, n*—the loss in viscosity determined from the difference in kinematic viscosity at 100 °C of pre-sheared and post-sheared fluid.

4. Summary of Test Method

4.1 A polymer-containing fluid is passed through a diesel injector nozzle at a shear rate that may reduce its kinematic viscosity. The percent viscosity loss is a measure of the mechanical shear stability of the fluid.

NOTE 7—This test method may also be used for oils not containing polymer. It might not be known whether an oil submitted for test contains a polymer.

5. Significance and Use

5.1 This test method evaluates the percent viscosity loss of fluids resulting from physical degradation in the high shear nozzle device. Thermal or oxidative effects are minimized.

5.2 This test method may be used for quality control purposes by manufacturers of polymeric lubricant additives and their customers.

5.3 This test method is not intended to predict viscosity loss in field service in different field equipment under widely varying operating conditions, which may cause lubricant viscosity to change due to thermal and oxidative changes, as well as by the mechanical shearing of polymer. However, when the field service conditions, primarily or exclusively, result in the degradation of polymer by mechanical shearing, there may be a correlation between the results from this test method and results from the field.

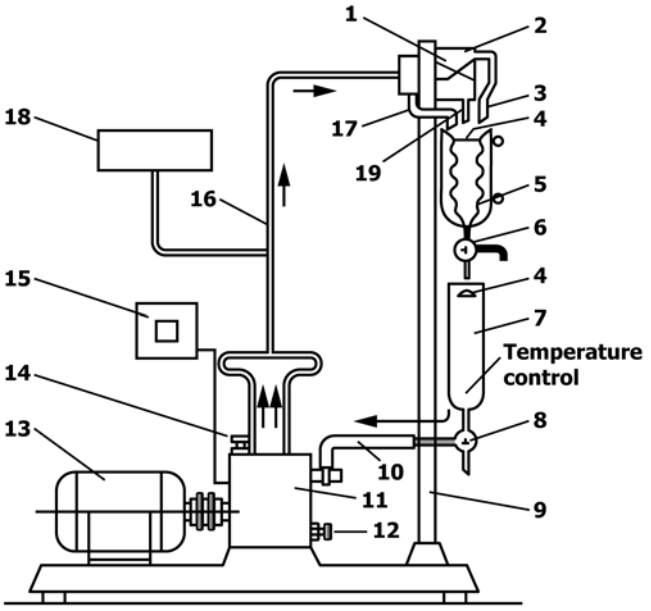
6. Apparatus

6.1 The apparatus consists of a fluid reservoir, a double-plunger pump with an electric motor drive, an atomization chamber with a diesel injector spray nozzle, and a fluid cooling vessel, installed in an area with an ambient temperature of 20 °C to 25 °C (68 °F to 77 °F). Fig. 1 shows the schematic representation of equipment.[4]

6.1.1 *Fluid Reservoir*—In Fig. 1, the fluid reservoir (7) is open on the top, has approximately a 250 mL capacity with graduation of a maximum of 5 mL, has a 45 mm (1.772 in.) inner diameter, and is calibrated in units of volume. It is fitted with an internal fluid distributor as detailed in Fig. 2. A 40 mm (1.575 in.) diameter watch glass with serrated edges is an acceptable distributor plate. The distributor reduces the tendency of fluid channeling. Temperature is measured by a thermometer suspended in the center of the fluid reservoir. The bottom of the thermometer bulb shall be 10 mm to 15 mm above the entrance to the drain tube opening. Other temperature-measuring equipment positioned at the same location may also be used. The outlet is equipped with a three-way stopcock (8). The three-way stopcock is of a cone type with a nonexchangeable solid plug with an 8 mm (0.315 in.) nominal bore size. Transparent plastic tubing, (10) in Fig. 1, is used to connect the three-way stopcock to the pump inlet.

6.1.2 *Double-Plunger Injection Pump*—In Fig. 1, the injection pump (11) is defined as Bosch PE 2 A 90D 300/3 S2266. This pump is equipped with a stroke counter (15), venting screw (14), and a flow rate adjusting screw (12).

6.1.3 *Injection Pump,* driven by a three-phase electric motor (13) in Fig. 1, rated at a speed of 925 r⁄min ± 25 r⁄min.



Legend:
(1) Spray nozzle
(2) Atomization chamber
(3) Outlet of the atomization chamber
(4) Distributor plate
(5) Fluid-cooling vessel
(6) Three-way cock downstream of glass
(7) Fluid reservoir
(8) Three-way cock downstream of glass container
(9) Support column
(10) Connection with pump-suction opening
(11) Double-plunger injection pump
(12) Pump setting screw
(13) Electric motor
(14) Venting screw/pump
(15) Stroke counter
(16) Pressure tubing from pump to injector
(17) Return line for overflowing liquid
(18) Pressure sensing device
(19) Drain line of atomization chamber

FIG. 1 Apparatus for Shear Stability Testing

[4] Throughout, the numbers in parentheses refer to the legend in Fig. 1.