Designation: D6278 – 20a

Standard Test Method for Shear Stability of Polymer Containing Fluids Using a European Diesel Injector Apparatus[1]

This standard is issued under the fixed designation D6278; 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 evaluation of the shear stability of polymer-containing fluids. The test method measures the percent viscosity loss 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.

NOTE 1—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 2—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 3—Test Method D5275 also shears oils in a diesel injector apparatus but may give different results.

NOTE 4—This test method has different calibration and operational requirements than withdrawn Test Method D3945.

NOTE 5—Test Method D7109 is a similar procedure that measures shear stability at both 30 and 90 injection cycles. This test method uses 30 injection cycles only.

1.2 The values stated in SI units are to be regarded as the standard.

1.2.1 *Exception*—Non-SI units are provided in parentheses.

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 precautionary 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

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)

D7109 Test Method for Shear Stability of Polymer-Containing Fluids Using a European Diesel Injector Apparatus at 30 Cycles and 90 Cycles

2.2 *Coordination European Council (CEC) Standard:*[3]

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

3. Terminology

3.1 *Definitions:*

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.

[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**

3.2.3 *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 causes polymer molecules to degrade. The resultant degradation reduces the kinematic viscosity of the fluid under test. The percent viscosity loss is a measure of the mechanical shear stability of the polymer-containing fluid.

5. Significance and Use

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

5.2 This test method is 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. A1.1 shows the schematic representation of equipment.

6.1.1 *Fluid Reservoir,* In Fig. A1.1, the fluid reservoir (7)[4] is open on the top, has approximately a 250 mL capacity with gradation 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. A1.2. 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. A1.1, is used to connect the three-way stopcock to the pump inlet.

6.1.2 *Double-Plunger Injection Pump,* In Fig. A1.1 (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 flow rate adjusting screw (12).

6.1.3 *Injection Pump,* driven by a three-phase electric motor (13) in Fig. A1.1, rated at a speed of 925 r/min ± 25 r/min.

6.1.3.1 This motor runs at 925 r/min on the 50 Hz current prevalent in Europe; it will run at approximately 1100 r/min on 60 Hz current. The 1100 r/min speed is not acceptable in this procedure. A suitable means shall be taken to ensure the prescribed 925 r/min ± 25 r/min speed to the injection pump. One acceptable method is to use a 6 to 5 speed reducer.

6.1.4 *Outlet of Injection Pump,* connected to the atomization chamber using high pressure steel tubing. The atomization chamber (2) in Fig. A1.1 is defined in more detail in Fig. A1.3. To minimize foam generation, the spray chamber is designed so that the fluid under test exits from the nozzle into a chamber filled with the test fluid. A drain tube (17) fitted with a two-way stopcock is included to minimize contamination from the previous test during the system cleaning steps. The diesel injector nozzle is a Bosch DN 8 S 2-type pintle nozzle injector, number 0434 200 012, installed in a Bosch KD 43 SA 53/15 nozzle holder. The nozzle holder includes a filter cartridge.

NOTE 6—Take great care to avoid damage to the precision parts of the fuel injection equipment (the plunger and barrel in the pump and the nozzle valve assembly). Service work on the equipment should be performed by a diesel fuel injector pump specialist or with reference to the manufacturer's service manual.[5]

NOTE 7—An unusual rapid rise in gauge pressure during testing may signify filter blockage. When this occurs, the filter cartridge shall be replaced.

6.1.5 A pressure sensing device (18), such as a glycerol-filled pressure gauge or *electronic, digital display pressure indicator*, shall be installed and separated from the line by a pressure snubber or needle valve to suitably dampen pressure surges. The pressure sensing device shall be able to take readings with a display resolution of at least 0.1 MPa when a glycerol-filled pressure gauge is being used, or to 0.01 MPa when an electronic pressure device is employed. The pressure device shall be occasionally pressure tested to ensure accuracy.

6.1.6 *Fluid Cooling Vessel,* ((5) in Fig. A1.1), used to maintain the specified temperature of the test fluid, as indicated at the outlet of the fluid reservoir. This vessel is a glass container with exterior cooling jacket constructed so that the heat transfer surface of the jacket is spherical. The exterior jacket diameter, d_1, is approximately 50 mm (1.969 in.). The interior heat transfer surface, d_2, is approximately 25 mm (0.984 in.) in diameter. The overall length, L, is approximately 180 mm (7.087 in.). A distributor plate, similar in design to the distributor plate in the fluid reservoir, is positioned in the upper portion of the fluid cooling vessel to ensure contact between the fluid and the cooling surface. The discharge from the fluid cooling vessel is through a three-way stopcock of the same design used on the discharge of the fluid reservoir. If using a

[4] The number in parentheses refers to the legend in Fig. A1.1.

[5] Repair Instructions for Diesel Injection Pumps Size A, B, K and Z, Bulletin WJP 101/1 B EP, Robert Bosch GmbH, 2800 South 25th Ave., Broadview, IL 60153.