Designation: D1092 – 26

Standard Test Method for Measuring Apparent Viscosity of Lubricating Greases[1]

This standard is issued under the fixed designation D1092; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This test method covers measurement, in poises, of the apparent viscosity of lubricating greases in the temperature range from −54 °C to 38 °C (−65 °F to 100 °F). Measurements are limited to the range from 25 P to 100 000 P at 0.1 s^{-1} and 1 P to 100 P at 15 000 s^{-1}.

NOTE 1—At very low temperatures the shear rate range may be reduced because of the great force required to force grease through the smaller capillaries. Precision has not been established below 10 s^{-1}.

1.2 This standard uses inch-pound units as well as SI (acceptable metric) units. The values stated first are to be regarded as standard. The values given in parentheses are for information only. The capillary dimensions in SI units in Fig. A1.1 and Fig. A1.2 are standard.

1.3 This test method uses mercury thermometers. **WARNING**—Mercury has been designated by many regulatory agencies as a hazardous substance that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Use caution when handling mercury and mercury-containing products. See the applicable product Safety Data Sheet (SDS) for additional information. The potential exists that selling mercury or mercury-containing products, or both, is prohibited by local or national law. Users must determine legality of sales in their location. The responsible subcommittee, D02.G0, continues to explore alternatives to eventually replace the mercury thermometers.

1.3.1 In addition, temperature measuring devices such as liquid-in-glass thermometers (Specifications E1 and E2251), thermocouples, thermistors, or platinum resistance thermometers that provide equivalent or better accuracy and precision, that cover the temperature range for ASTM thermometer 49C, may be used.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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]

D88 Test Method for Saybolt Viscosity

D217 Test Methods for Cone Penetration of Lubricating Grease

D3244 Practice for Utilization of Test Data to Determine Conformance with Specifications

E1 Specification for ASTM Liquid-in-Glass Thermometers

E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

3. Terminology

3.1 *Definitions:*

3.1.1 *apparent viscosity, n—of a lubricating grease*, is the ratio of shear stress to shear rate calculated from Poiseuille's equation, and is measured in poises (see 10.1).

3.1.2 *capillary, n—for the purpose of this test method*, a capillary is any right cylindrical tube having a length to diameter ratio of 40 to 1.

3.1.3 *shear rate, n*—the rate at which a series of adjacent layers of grease move with respect to each other; proportional to the linear velocity of flow divided by the capillary radius, and is thus expressed as reciprocal seconds.

4. Summary of Test Method

4.1 The sample is forced through a capillary by means of a floating piston actuated by the hydraulic system. From the

[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.G0.02 on Consistency and Related Rheological Tests.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* 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**

predetermined flow rate and the force developed in the system, the apparent viscosity is calculated by means of Poiseuille's equation. A series of eight capillaries and two pump speeds are used to determine the apparent viscosity at sixteen shear rates. The results are expressed as a log-log plot of apparent viscosity versus shear rate.

5. Significance and Use

5.1 Apparent viscosity versus shear rate information can be useful in predicting pressure drops in grease distribution systems under steady-state flow conditions at constant temperature.

6. Apparatus

6.1 The assembled pressure viscometer consists of four major divisions, the power system, the hydraulic system, the grease system (described in the annex and shown in Fig. 1), and a bath of optional design. Fig. 3 is a photograph of the first three divisions as commonly used at room temperature. This form of the apparatus can be used with a cylindrical insulated tank 178 mm (7 in.) in diameter and 508 mm (20 in.) deep. The bath medium may be kerosene or alcohol cooled manually with dry ice. Alternatively the grease system, the grease and hydraulic system, or all three major divisions can be built into any liquid or air bath that will cover the temperature range and maintain the grease at test temperature ±0.25 °C (±0.5 °F).

7. Sampling

7.1 A single filling of the grease cylinder requires about 0.223 kg (½ lb) of grease which is the minimum size sample.

NOTE 2—It is possible for an experienced operator to complete the 16 single determinations with a single filling. However, some samples reach the equilibrium pressure slowly, making it advisable to have a sample of several pounds available.

7.2 Generally no special preparation of the sample is necessary.

NOTE 3—The apparatus works the samples to some extent as they pass through the capillary. Somewhat better precision is obtained if they are previously worked as described in Test Methods D217. Working of some greases may cause aeration.

NOTE 4—It is desirable to filter some greases through a 60-mesh screen to prevent plugging the No. 8 capillary. Follow prudent laboratory practice to keep equipment cleaned and flushed before use.

8. Calibration and Standardization

8.1 To calibrate the hydraulic system, remove the grease cylinder and replace it with a needle valve. Select a hydraulic oil of about 2000 cSt (2000 mm^2/s) viscosity at the test temperature. Fill the system with hydraulic oil and circulate the oil until it is free of air bubbles. At atmospheric pressure, quickly place a 60 mL Saybolt receiving flask (Test Method D88), under the outlet and start a timer. Determine the delivery time for 60 mL and calculate the flow rate in cubic centimetres per second assuming 1 mL equal to 1 cm^3. Repeat this observation at 500 psi, 1000 psi, 1500 psi (3.45 MPa, 6.89 MPa, 10.4 MPa) and at sufficient pressures above 1500 psi to develop a calibration curve of the type as shown in Fig. 4. The developed curve of the type is used to correct flow rates when grease is dispensed. Repeat the calibration at intervals to determine if wear is changing the pump flow.

8.2 An alternative procedure for the calibration of the hydraulic system is the measurement of the rate of flow of the test grease. To cover the desired range of shear rates, flow rates over an approximate range of pressure are determined. Any suitable means of measuring the rate of grease flow may be used.

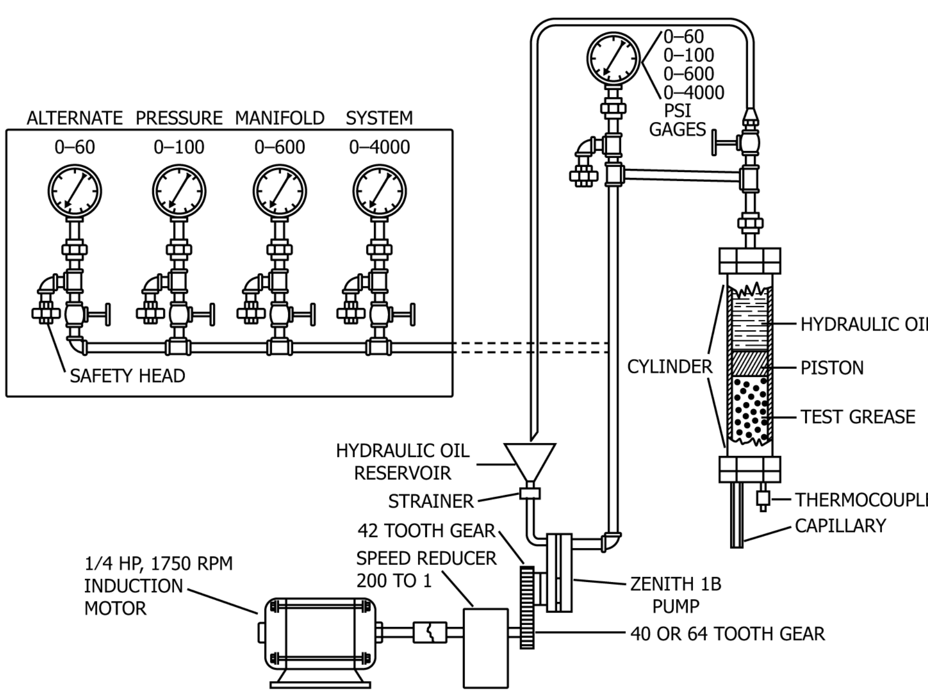

FIG. 1 Schematic Drawing of Apparatus