Designation: D 5621 – 94~~4~~01

An American National Standard

Standard Test Method for Sonic Shear Stability of Hydraulic Fluids[1]

This standard is issued under the fixed designation D 5621; 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 ~~a~~ hydraulic fluids in terms of the final viscosity that results from irradiating a sample of the hydraulic fluid in a sonic oscillator.

1.2 Evidence has been presented that a good correlation exists between the shear degradation that results from sonic oscillation

[1] This test method is under the jurisdiction of ASTM Committee ~~D-2~~ D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee ~~D02.07.0B~~ D02.07 on ~~High Temperature Rheology of Non-Newtonian Fluids.~~ Flow Properties.

Current edition approved ~~Oct. 15, 1994.~~ Aug. 10, 2001. Published ~~D~~ September 2001. Originally published as D 5621-94. Last previous edition D 5621-94.

and that obtained in a vane pump test procedure.[2]

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

1.4 This test method uses millimetres squared per second (mm^2/s), an SI unit, as the unit of viscosity. For information, the equivalent unit, cSt, is shown in parentheses.

2. Referenced Documents

2.1 *ASTM Standards:*

D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids ~~(and the~~ (the Calculation of Dynamic Viscosity)[3]

D 2603 Test Method for Sonic Shear Stability of Polymer-Containing Oils[4]

3. Summary of Test Method

3.1 A convenient volume of hydraulic fluid is irradiated in a sonic oscillator for a period of time and the change in viscosity is determined by Test Method D 445. A standard reference fluid containing a readily sheared polymer is run frequently to ensure that the equipment imparts a controlled amount of sonic energy to the sample.

3.2 The conditions to obtain the data for the precision statement were: 30 mL sample, 12.5 min calibration, and 40 min sample irradiation at 0°C jacket temperature.

4. Significance and Use

4.1 This test method was developed using Test Method D 28~~6~~03 – 91.

4.2 This test method permits the evaluation of shear stability with minimum interference from thermal and oxidative factors that may be present in some applications. It has been found applicable to fluids containing both readily sheared and shear-resistant polymers. Correlation with performance in the case of hydraulic applications has been established.

5. Apparatus

5.1 *Sonic Shear Unit*, fixed frequency oscillator and sonic horn.[5]

5.2 *Auxiliary Equipment*—To facilitate uniform performance, the following auxiliary equipment is recommended:

5.2.1 *Cooling Bath or Ice Bath*, to maintain a jacket temperature of 0°C.

5.2.2 *Griffin 50–mL Beaker*, borosilicate glass.

5.2.3 *Sonic-Insulated Box*, to enclose the sonic horn to reduce the ambient noise level produced by the sonic shear unit.

5.3 *Viscometer*, any viscometer and bath meeting the requirements of Test Method D 445.

6. Reference Fluids

6.1 The reference fluid is ASTM Reference Fluid B,[6] a petroleum oil containing a polymer capable of being broken down by turbulence at high rates of shear. This oil has a viscosity of about 13.5~~6~~ mm^2/s (cSt) at 40°C. The viscosity of a specific lot is supplied by the provider of that lot.

7. Calibration of Apparatus

7.1 The reference fluid provides a practical way to define the performance (severity level) of a sonic oscillator unit so that satisfactory comparison can be made between tests run on different days in the same unit and between tests run with different units.

7.2 The decrease in viscosity observed for a given hydraulic fluid on irradiation in an oscillator unit depends on a number of factors; these include sample volume, irradiation time, and oscillator power setting. Frequency of the generator is 23 ± 2 kHz. Typical power settings are in the range of 50 watts. Manual tuning of the oscillator-horn combination is also required in some instruments in order to ensure efficiency of energy coupling between the two units. The procedure described in 7.3 is recommended for establishing a reproducible performance level for a given unit.

7.3 Confirm and record the 40°C viscosity of the reference fluid. Introduce 30 mL (room temperature) of the reference fluid into the 50–mL Griffin beaker. Immerse the beaker in ice water or a constant temperature bath at 0°C until the sample fluid level is below the liquid level in the bath. The beaker should be maintained in a vertical position in the bath. Secure beaker in this position and condition the sample for 12.5 min before commencing irradiation. Immerse the sonic horn into the sample fluid until the tip

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[2] Stambaugh, R. L., Kopko, R. J., and Roland, T. F., "Hydraulic Pump Performance—A Basis for Fluid Viscosity Classification", SAE Paper No. 901633. Available from Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

[3] *Annual Book of ASTM Standards*, Vol 05.01.

[4] *Annual Book of ASTM Standards*, Vol 05.02.

[5] In the round robin program, equipment from Sonic Systems, Inc., 109 Pheasant Run, Newtown, PA 18040 and Heat Systems Ultrasonic, Inc., 1938 New Highway, Farmingdale, NY 11735, were found to be satisfactory.

[6] This fluid can be obtained from ~~Rohm and Haas Co., Research Laboratories, Spring House,~~ RohMax USA, 723 Electronic Drive, Horsham, PA ~~19477-0904.~~ 19044–2228.

is at least 10 mm below the surface of fluid (see Fig. 1) in order to ensure that the tip remains submerged during the test. Exercise care to avoid contact of the tip with the bottom of the beaker as this will shorten tip life. The horn should be placed in a vertical position in the fluid and centered in the beaker (a weighted ring stand may be used to support the horn in this position). True vertical positioning is not critical and is intended primarily to minimize liquid splashing during irradiation. Irradiate the fluid for 12.5 min at a preselected power setting. Determine the decrease in reference fluid viscosity measured at 40°C. Repeat as necessary to determine the proper power setting to produce a viscosity change at 40°C of 15.0 % (±1 %). Use this power setting for subsequent test runs. Daily recalibration of the apparatus is required because the power setting required to produce a stated viscosity loss will probably vary from day to day. Experience with a given apparatus set will determine whether more frequent calibration is required. Calibration in this manner will ensure that repeatable severity levels are established.

8. Procedure

8.1 Clean the sonic horn using a lintless wiper and optional solvent and calibrate the apparatus as described in 7.3. Introduce 30 mL of the hydraulic fluid sample to be tested into a clean 50–mL Griffin beaker and immerse in the constant temperature bath at 0°C. The beaker should be in a vertical position. Allow the sample to equilibrate for 12.5 min. Immerse the sonic horn in the fluid as described in 7.3. Irradiate the sample for 40 min at exactly the same power setting determined in 7.3. Upon completion of irradiation, remove the sample and clean the sonic horn in preparation for the next run.

8.2 Determine the viscosity of the sample by Test Method D 445 before and after irradiation.

9. Report

9.1 Report the initial and irradiated 40°C viscosity of the hydraulic fluid.

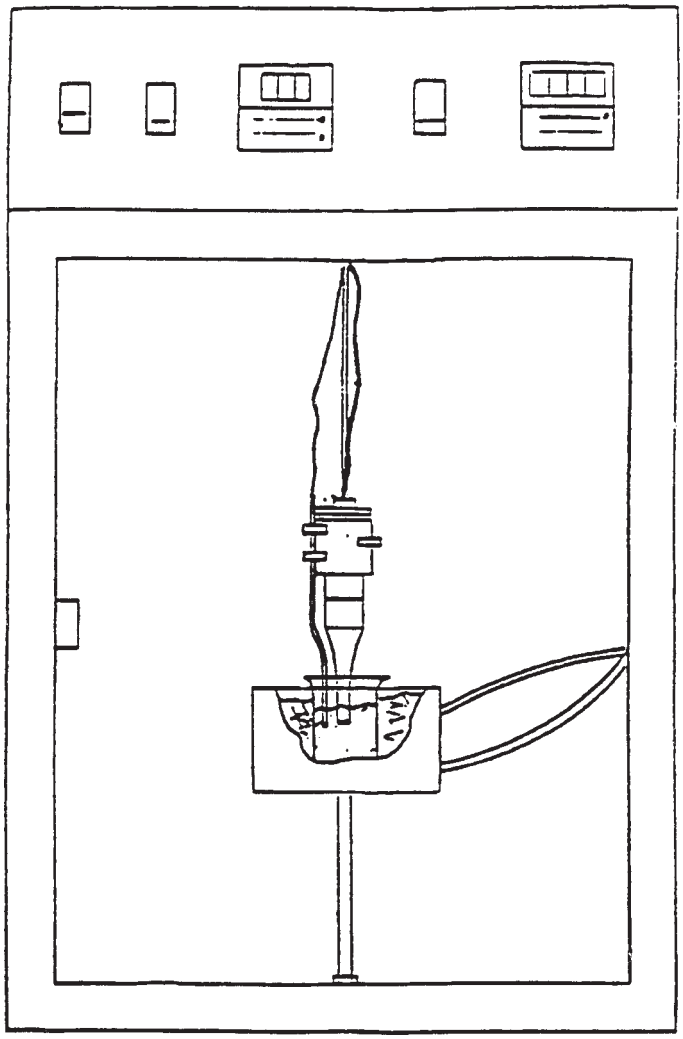

FIG. 1 Schematic of Sonic Probe Type Apparatus, Support Systems, Cabinet, and Power Supply

10. Precision and Bias [7]

10.1 *Repeatability*—The difference between two independent results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, differ from the mean by greater than 0.38 mm^2/s (cSt) in only one case in twenty.

10.2 *Reproducibility*—The difference between two independent results obtained by different operators working in different laboratories on identical test material would, in the long run, in the normal and correct operation of the test method, differ from the mean by greater than 0.60 mm^2/s (cSt) in only one case in twenty.

10.3 *Bias*—The bias of this test method has not been determined because there is insufficient data on the relevant reference (test) standard.

11. Keywords

11.1 hydraulic fluid; shear stability; sonic shear test; viscosity stable

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[7] Supporting data are available from ASTM Headquarters. Request RR: D02-1337.