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Standard Test Method for Thermal Stability of Hydraulic Fluids¹

This standard is issued under the fixed designation D 2160; 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 determination of the thermal stability of fluids. In this test method the volatile decomposition products are in continuous contact with the fluid during the test. To eliminate possible catalytic metal effects, the fluid is confined in a glass apparatus. To remove the variable of oxidation, air is removed by vacuum prior to the initiation of the test. It must be remembered that this test method will not measure the thermal stability threshold (the temperature at which volatile oil fragments begin to form) but instead will indicate bulk fragmentation occurring at a specified temperature and testing period. (**Warning: Explosion Hazard**—Due to potential decomposition and generation of high-pressure gas at 260 to 315°C (500 to 600°F), this test method is not suitable for aqueous-base fluids or other fluids which generate high-pressure gas at these temperatures.)

1.2 The values stated in S1 are the standard.

1.3 *This standard does not purport to address all of the safety problems, 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.* For specific precautionary statements, see 6.1 and 8.9.

2. Referenced Documents

2.1 ASTM Standards:

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)²

D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration²

D974 Test Method for Acid and Base Number by Color-Indicator Titration²

3. Terminology

3.1 Definition:

3.1.1 *thermal stability*—the resistance to permanent changes in properties caused solely by heat.

4. Summary of Test Method

4.1 The fluid is charged in a thermal stability test cell which is tightly sealed under vacuum to remove and preclude the presence of oxygen and water. The fluid is then

heated at a given temperature and for a given period of time, and then examined for any physical or chemical changes.

5. Significance and Use

5.1 This test method differentiates the relative stability of hydraulic fluids at elevated temperatures in the absence of air and water under the conditions of the test. Thermally unstable fluids form acidic contaminants which can cause hydraulic system malfunctions due to corrosion or change in viscosity of the fluid. The degree of correlation between this test and service performance at normal operating temperatures has not been determined.

6. Apparatus

6.1 *Test Cell*—The test cell shall be a glass tube, 15 mm in inside diameter, 20 mm in outside diameter, and 250 mm in length,³ with sufficient capacity to contain 20 ml of fluid and to permit heating and drawing the tube to a sealed end reasonably above the fluid level. A heavy-walled steel sample holder⁴ of proper size to contain the sealed glass tube also should be provided for safety reasons.

6.2 *Heating Bath*—The bath shall be capable of being controlled within $\pm 2.2^\circ\text{C}$ (4°F) at test temperatures of 260 and 316°C (500 and 600°F) and shall permit complete immersion of the test cell. The temperature gradient between fluid sample and the heating bath should be kept at a minimum (less than 1°C is recommended). An aluminum-block type bath is recommended for safety. The design of the apparatus shall be such as to permit the test fluid to reach the desired temperature within 15 min after insertion into the bath.

7. Preparation of Apparatus

7.1 *Cleaning Test Cell*—Since each test will necessitate a new test cell, cleaning is relatively simple. Scrubbing the new test cell with a suitable detergent, followed by a distilled water rinse and thorough drying, is sufficient.

8. Procedure

8.1 Adjust the heating bath to the proper test temperature.

8.2 Filter⁵ a portion of the fluid sample through a filter to remove particle contaminants.

³ A borosilicate glass combustion tube with closed end construction has been found satisfactory.

⁴ A sample holder measuring 25 mm in inside diameter, 5 mm in thickness, and 250 mm in length, has been found satisfactory for this purpose.

⁵ A (Millipore) (SMWP 04700, Cellulosic, 5 μm porosity) membrane type filter or equivalent has proven satisfactory. If there is a test fluid filter material incompatibility, a fluorocarbon membrane may be used. A Millipore FSLW 04700 3- μm porosity membrane or equivalent has proven satisfactory for example with phosphate ester fluids.

¹ This test method is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.N on Hydraulic Fluids.

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² Annual Book of ASTM Standards, Vol 05.01.

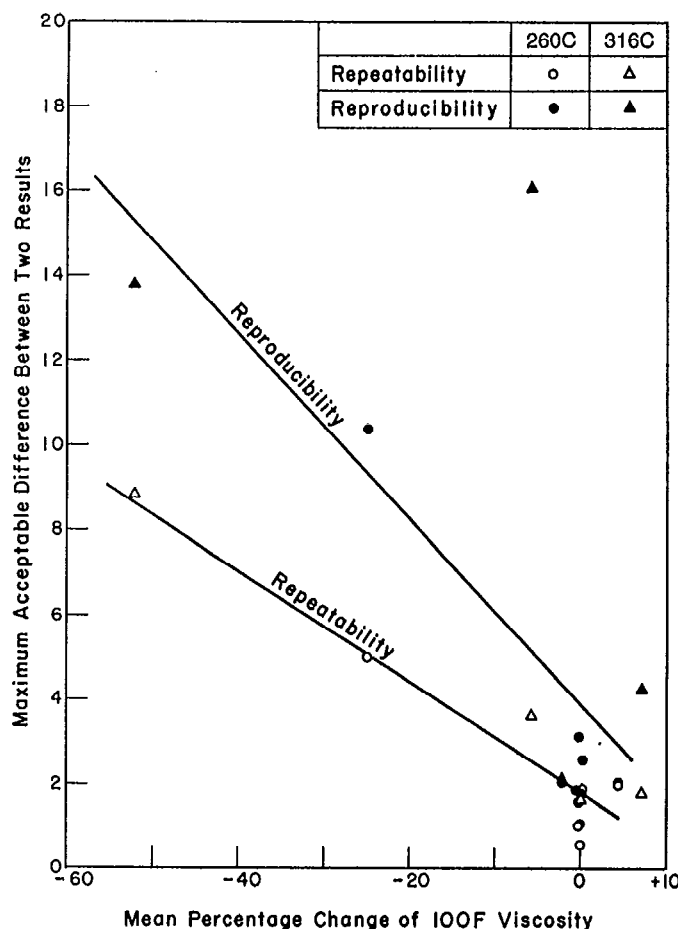
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FIG. 1 Precision of Viscosity Change Measurements

8.3 Fill a clean volumetric pipet with the filtered sample. Extend the pipet tip below the constricted area of the test cell and introduce in this manner 20 ml of fluid sample.

8.4 Attach the test cell to a vacuum pump capable of reducing the pressure to approximately 0.13 kPa (1.0 mm Hg) and degas the cell and its contents with agitation for 10 min.

NOTE 1—For fluids which may show strong affinity for trace amounts of water (above 0.02 %) more stringent conditions may be required: for example, vigorous agitation of the sample at 80°C (176°F) and 0.04 kPa (0.3 mm Hg) pressure for 10 min.

8.5 With the test cell under vacuum, seal off the constricted area by heat. Weigh the sealed test cell to the nearest 0.1 g.

8.6 Insert the sealed glass tube in the steel holder and place the assembly in the heating bath at the specified test temperature for a period of 6 h. To conduct the test at temperatures above 316°C (600°F) is considered hazardous and is not recommended.

8.7 At the conclusion of the heating period, remove the test cell and allow to cool to ambient temperature. Visually observe the appearance of the fluid sample for any insolubles, or other changes in the fluid.

8.8 Reweigh the test cell to determine the percent evaporation loss.

NOTE 2—If the evaporation loss is greater than 0.5 weight % repeat the test, since this would indicate tube leakage.

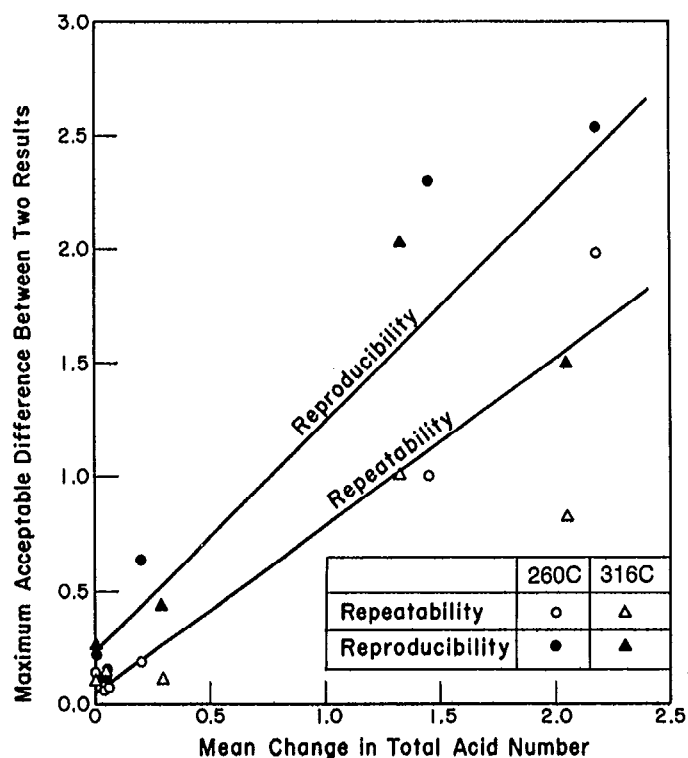


FIG. 2 Precision of Acid Number Change Determinations

8.9 Remove the fluid by carefully breaking the test cell. This may be accomplished by scratching the cell near the top and applying a hot glass rod at the scratch mark.

NOTE 3—Use a wire-reinforced transparent plastic shield as a safety precaution when opening the glass test cell.

8.10 Inspect the tube for insolubles and gummy materials.

8.11 Determine the viscosity at 40°C (104°F) on both the original fluid and the fluid after exposure to heat in accordance with Test Method D 445.

8.12 Determine the neutralization number on both the original fluid and the fluid after exposure to heat in accordance with Test Methods D 664 or D 974.

8.13 Run duplicate tests.

9. Report

9.1 The report shall include the following:

9.1.1 Visual appearance of fluid and test cell.

9.1.2 Change in the neutralization number of the fluid sample (average of duplicate tests).

9.1.3 Percentage change in viscosity in centistokes (millimeters squared per second) at 40°C (104°F) for the fluid sample.

9.1.4 Test temperature, and

9.1.5 Time.

10. Precision and Bias

10.1 *Precision*—The precision of this test method as determined by the statistical examination of interlaboratory test results is as follows:

10.1.1 *Repeatability*—The difference between successive results obtained by the same operator with the same apparatus under constant operating conditions on identical test