Designation: D8277 – 20

Standard Test Method for Wet Filterability of Lubricants and Hydraulic Fluids by Mass Flow Technique[1]

This standard is issued under the fixed designation D8277; 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 determination of the wet filterability of lubricants and hydraulic fluids based upon mass flow rate measurements through a 0.8 µm membrane after ageing of the fluid in the presence of water. The procedure applies to lubricants and hydraulic fluids that are formulated with American Petroleum Institute (API) Group I, II, III, IV and certain V base stocks. Products formulated with water or base stocks that are heavier than water are out of scope.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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.*

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]

D1193 Specification for Reagent Water

D1401 Test Method for Water Separability of Petroleum Oils and Synthetic Fluids

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D6300 Practice for Determination of Precision and Bias Data for Use in Test Methods for Petroleum Products and Lubricants

2.2 *ISO Standards:*[3]

ISO 13357 Petroleum products – Determination of the filterability of lubricating oils – Part 1: Procedure for oils in the presence of water

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *filterability, n*—the ability of lubricants and hydraulic fluids to pass through fine filters without plugging them; it is a dimensionless number that is the ratio between two filtration rates.

3.1.2 *Stage I filterability, n*—the ratio, expressed as a percentage, between 200 g and the mass of oil filtered in the time that 200 g would have theoretically taken, assuming no plugging of the membrane; oils having good Stage I filterability, but only a poor Stage II performance, would be unlikely to give performance problems in use, unless extremely fine system filters are utilized.

3.1.3 *Stage II filterability, n*—the ratio, expressed as a percentage, between the flow rate near the start of filtration, and the flow rate between 160 g and 240 g of filtered mass; an oil with good Stage II filterability would be unlikely to give filtration problems even in the most extreme conditions or with fine (less than 5 µm) filtration present; it would thus be suitable for use in more critical hydraulic and lubrication systems.

3.2 *Symbols:*

3.2.1 F_I—Stage I filterability index, dimensionless.

3.2.2 F_{II}—Stage II filterability index, dimensionless.

3.2.3 M—actual mass of oil filtered at T_m, g.

3.2.4 T_8—time corresponding to 8 g of oil filtered, s.

3.2.5 T_{40}—time corresponding to 40 g of oil filtered, s.

3.2.6 T_{160}—time corresponding to 160 g of oil filtered, s.

3.2.7 T_{240}—time corresponding to 240 g of oil filtered, s.

[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.N0 on Hydraulic Fluids.

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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 International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

3.2.8 T_m—theoretical time for 192 g of oil to filter, s.

4. Summary of Test Method

4.1 In this test method, fluid is treated with water at an elevated temperature, filtered under specific conditions through a membrane of 0.8 µm mean pore diameter, and the times for the specific filtrate masses are recorded. Filterabilities are calculated from ratios of the mass flow rate near the start of the test to the flow rate at later stages. The result of the test is the average of three determined values.

NOTE 1—ISO 13357 is a volume flow rate based method for measuring the filterability of hydraulic fluids and lubricants. This standard test method described herein was developed to provide a mass flow rate based method for measuring filterability to reduce operator error and facilitate automation.

5. Significance and Use

5.1 Precision equipment and high pressure hydraulic machinery require filtered lubricants and fluids to prevent damage from the circulation of hard particulate contaminants. Three types of particulate contaminants are present in lubricants and hydraulic fluids: built in contaminants from the machinery assembly process, generated contaminants from equipment wear, and contaminants that enter from external sources. Water can also enter machinery lubrication and hydraulic systems through fill ports, defective seals, corroded heat exchangers, and reservoir breathers in the form of rain water, cleaning solutions, process water, metalworking fluids, coolants, and humid air.

5.2 The ability of lubricants and hydraulic fluids to retain their filterability in the presence of moisture is critical for efficient and reliable machine performance. Normally, the pressure differential across a filter will increase gradually as it accumulates dirt, sludge, and wear debris. In order to prevent the filter from collapsing, bypass valves in the filter assembly open when the differential pressure gets too high. If a filter becomes blocked by additives that precipitate due to the presence of contaminating water, the bypass valve will open. This can lead to a machine shutdown or circulation of damaging particles throughout the machine.

6. Apparatus

6.1 *Beaker,* 500 mL or other size suitable for collecting the filtrate.

NOTE 2—A 300 mL graduated cylinder may also be used but overflows can occur with low-density oils.

6.2 *Bottles,* 500 mL of laboratory type with screw caps. The exact shape of the bottle is unimportant, and 500 mL conical flasks may be used. The neck should be fairly narrow, but shall be wide enough to accept the stirrer (6.6). It is essential that the base of the bottle be fairly flat.

6.3 *Filtration Apparatus,* constructed of stainless steel, consisting of a lidded funnel of at least 350 mL capacity, and a funnel base with filter support, such that a membrane filter (6.5) can be clamped between the sealing surfaces of the funnel and the base by means of a metal clamp or other suitable air-tight closure.

6.4 *Forceps,* spade ended.

6.5 *Membrane Filters,* of mixed cellulose esters, diameter 47 mm and mean pore size of 0.8 µm.

NOTE 3—Membranes of an equivalent specification to Millipore filter membranes, catalogue number AAWP 047 have been found satisfactory.

6.6 *Stirring Paddle,* made of chromium-plated or stainless steel and conforming to the following dimensions:

Length, mm	120 ± 1.5
Width, mm	19 ± 0.5
Thickness, mm	1.5 ± 0.15
Paddle corner radius of curvature, mm	1.6 max

It is mounted on a vertical shaft of similar metal, approximately 6 mm in diameter, connected to a drive mechanism which rotates the paddle on its longitudinal axis at 1500 rpm ± 15 rpm. The apparatus is of such design that, when the cylinder is clamped in position and the paddle assembly is lowered into the cylinder, a positive stop engages and holds the assembly when the lower edge of the paddles is 6 mm from the bottom of the cylinder. During the operation of the cylinder, the center of the bottom edge of the paddle shall not deviate more than 1 mm from the axis of rotation. When not in operation, the paddle assembly can be lifted vertically to clear the top of the graduated cylinder. (**Warning—**Paddle edges may be very sharp. Handle with care.) (**Warning—**A protective shield may be used to cover the rotating shaft of the stirrer.)

NOTE 4—The stirring paddle described above is based upon the requirements of Test Method D1401.

6.7 *Oven,* controlled at 70 °C ± 2.0 °C.

6.8 *Petri Dishes,* glass type.

6.9 *Pressure Gauge,* dial or digital type, capable of reading the required delivery pressures (see 11.4) ±5 kPa.

6.10 *Top Loading Balance,* with dynamic measurement mode. Capable of continuously recording 0.1 g mass at 0.1 s increments.

7. Reagents and Materials

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee of Analytical Reagents of the American Chemical Society, where such specifications are available.[4] Other grades may be used, provided it is first ascertained that the reagent of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 *Compressed Air or Nitrogen,* complete with regulator system capable of supplying air or nitrogen at nominal pressures between 50 kPa and 200 kPa. The air or nitrogen shall be dry and filtered.

7.3 *Propan-2-ol,* reagent grade.

[4] *ACS Reagent Chemicals, Specifications and Procedures for Reagents and Standard-Grade Reference Materials*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.