Designation: D6794 – 20ε1

Standard Test Method for Measuring the Effect on Filterability of Engine Oils After Treatment with Various Amounts of Water and a Long (6 h) Heating Time[1]

This standard is issued under the fixed designation D6794; 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.

ε[1] NOTE—Editorially updated TMC governance information in June 2022.

INTRODUCTION

Portions of this test method are written for use by laboratories that make use of ASTM Test Monitoring Center (TMC)[2] services (see Annex A1).

The TMC provides reference oils, and engineering and statistical services to laboratories that desire to produce test results that are statistically similar to those produced by laboratories previously calibrated by the TMC.

In general, the Test Purchaser decides if a calibrated test stand is to be used. Organizations such as the American Chemistry Council require that a laboratory utilize the TMC services as part of their test registration process. In addition, the American Petroleum Institute and the Gear Lubricant Review Committee of the Lubricant Review Institute (SAE International) require that a laboratory use the TMC services in seeking qualification of oils against their specifications.

The advantage of using the TMC services to calibrate test stands is that the test laboratory (and hence the Test Purchaser) has an assurance that the test stand was operating at the proper level of test severity. It should also be borne in mind that results obtained in a non-calibrated test stand may not be the same as those obtained in a test stand participating in the ASTM TMC services process.

Laboratories that choose not to use the TMC services may simply disregard these portions.

ASTM International policy is to encourage the development of test procedures based on generic equipment. It is recognized that there are occasions where critical/sole-source equipment has been approved by the technical committee (surveillance panel/task force) and is required by the test procedure. The technical committee that oversees the test procedure is encouraged to clearly identify if the part is considered critical in the test procedure. If a part is deemed to be critical, ASTM encourages alternative suppliers to be given the opportunity for consideration of supplying the critical part/component providing they meet the approval process set forth by the technical committee.

An alternative supplier can start the process by initiating contact with the technical committee (current chairs shown on ASTM TMC website). The supplier should advise on the details of the part that is intended to be supplied. The technical committee will review the request and determine feasibility of an alternative supplier for the requested replacement critical part. In the event that a replacement critical part has been identified and proven equivalent, the sole-source supplier footnote shall be removed from the test procedure.

For other information, refer to the research report of this test method.[3]

[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.B0 on Automotive Lubricants.

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[2] ASTM Test Monitoring Center, 203 Armstrong Drive, Freeport, PA 16229. This test method is supplemented by Information Letters and Memoranda issued by the ASTM Test Monitoring Center. This edition includes all information letters through No. 19-2. Users of this test method can contact the ASTM Test Monitoring Center to obtain the most recent of these.

1. Scope*

1.1 This test method covers the determination of the tendency of an oil to form a precipitate that can plug an oil filter. It simulates a problem that may be encountered in a new engine run for a short period of time, followed by a long period of storage with some water in the oil.

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:*[4]

D1193 Specification for Reagent Water

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4485 Specification for Performance of Active API Service Category Engine Oils

D5844 Test Method for Evaluation of Automotive Engine Oils for Inhibition of Rusting (Sequence IID) (Withdrawn 2003)[5]

D5862 Test Method for Evaluation of Engine Oils in Two-Stroke Cycle Turbo-Supercharged 6V92TA Diesel Engine (Withdrawn 2009)[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *calibrate, v*—to determine the indication or output of a device (e.g., thermometer, manometer, engine) with respect to that of a standard.

3.1.2 *calibration test, n*—a test, using a coded oil, conducted as specified in the test method.

3.1.2.1 *Discussion*—The test result is used to determine the suitability of the testing facility/laboratory to conduct such tests on non-reference oils.

3.1.3 *candidate oil, n*—an oil that is intended to have the performance characteristics necessary to satisfy a specification and is tested against that specification.

3.1.3.1 *Discussion*—It may contain additives to enhance certain properties. Inhibition of engine rusting, deposit formation, valve train wear, oil oxidation, and foaming are examples.

3.1.4 *engine oil, n*—a liquid that reduces friction or wear, or both, between the moving parts within an engine; removes heat, particularly from the underside of pistons; and serves as a combustion gas sealant for the piston rings.

3.1.4.1 *Discussion*—It may contain additives to enhance certain properties. Inhibition of engine rusting, deposit formation, valve train wear, oil oxidation, and foaming are examples. **D5862**

3.1.5 *non-reference oil, n*—any oil other than a reference oil–such as a research formulation, commercial oil, or candidate oil.

3.1.5.1 *Discussion*—Reference oils are used to calibrate testing facilities, to compare the performance of other oils, or to evaluate other materials (such as seals) that interact with oils.

3.1.6 *reference oil, n*—an oil of known performance characteristics, used as a basis for comparison.

3.1.6.1 *Discussion*—Reference oils are used to calibrate testing facilities, to compare the performance of other oils, or to evaluate other materials (such as seals) that interact with oils. **D5844**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *effective filter area, n*—that surface of a test filter that can receive the material to be filtered.

3.2.2 *new oil, n*—an unused oil having the identical formulation and base stock as the test oil.

3.2.3 *test oil, n*—the new oil with various amounts of water added.

3.2.3.1 *Discussion*—A potential precipitate in the test oil is induced by heating the oil and aging.

4. Summary of Test Method

4.1 Add deionized water to the test oil for a final solution of 0.6 %, 1.0 %, 2.0 %, or 3.0 % water in oil. The sample is heated to 70 °C for 6 h, followed by storage at room temperature. The sample is filtered and the flow rate is calculated determining the engine oil filterability characteristics.

5. Significance and Use

5.1 It is normal for some of the combustion products of an internal combustion engine to penetrate into the engine lubricant and be retained in it.

5.2 When an engine is run for a period of time and then stored over a long period of time, the by-products of combustion might be retained in the oil in a liquefied state.

5.3 Under these circumstances, precipitates can form that impair the filterability of the oil the next time the engine is run.

5.4 This test method subjects the test oil and the new oil to the same treatments such that the loss of filterability can be determined. The four water treatment levels may be tested individually, all four simultaneously, or any combination of multiple water treatment levels.

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1492. Contact ASTM Customer Service at service@astm.org.

[4] 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.

[5] The last approved version of this historical standard is referenced on www.astm.org.

5.5 Reference oils, on which the data obtained by this test method is known, are available.

5.6 This test method requires that a reference oil also be tested and results reported. Two oils are available, one known to give a low and one known to give a high data value for this test method.

NOTE 1—When the new oil test results are to be offered as candidate oil test results for a specification, such as Specification D4485, the specification will state maximum allowable loss of filterability (flow reduction) of the test oil as compared to the new oil.

6. Apparatus

6.1 The apparatus consists of a 25 mL burette, a filter holder with 25 µm automotive oil filter paper, and a source of 69 kPa ± 2 kPa air pressure. Discs of filter paper are cut to fit the holder and installed (see Fig. 1).

6.1.1 *Burette (glass or plastic),* 25 mL, with polytetrafluoroethylene (PTFE) stopcock and (1.8 ± 0.1) mm burette tip opening.

6.1.2 *Air Regulator,* capable of regulating air to a pressure of (69 ± 2) kPa.

6.1.3 *Filter Holder,* with effective filter area approximately 0.8 cm^2.

6.1.4 *Automotive Oil Filter Paper,* 25 µm porosity.[6]

6.2 *Blender,* capable of 18 000 r/min ±10 % without the container.

6.3 *Timer,* capable of timing 30 s ± 1 s.

6.4 *Container,* 250 mL, with blade compatible with the blender.

6.5 *Syringe,* 1000 µL.

6.6 *Glass Jars,* 60 mL, wide-mouth with inert lined lids.

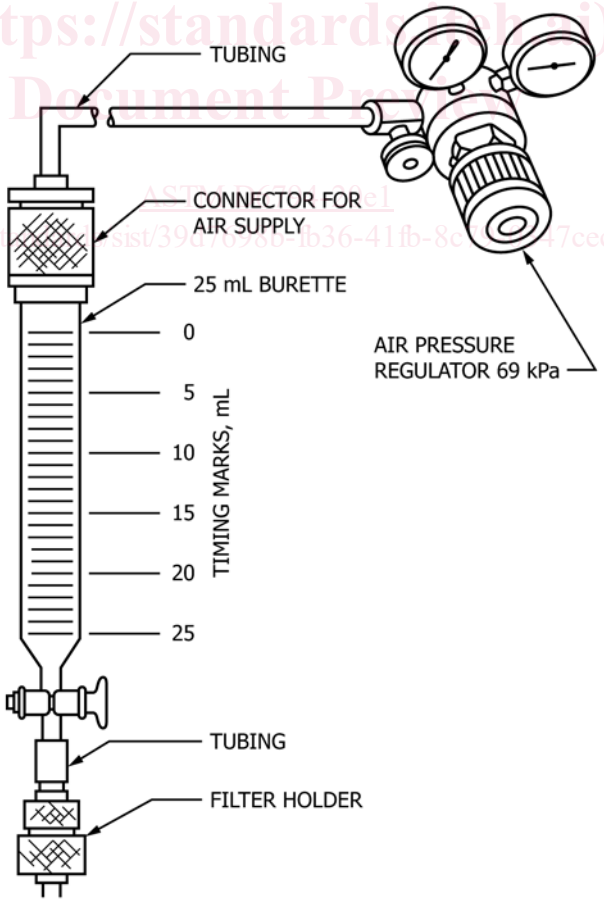
NOTE 2—Paperbacked lids may detach from lid and are not suggested for use.

6.7 *Mechanical Convection Oven,* capable of maintaining 70 °C ± 1 °C.

6.8 *Sensors (or equivalent timing devices),* capable of measuring sequential events to 1 s resolution.

6.9 *Tubing,* inert tubing used to connect to burette.

[6] The sole source of supply of the automotive oil filter paper known to the committee at this time is The Central Parts Distributor, OH Technologies Inc., P.O. Box 5039, Mentor, OH 44061-5039. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.



NOTE 1—Filter holder has approximate area of 0.8 cm^2. It contains automotive oil filter paper (25 µm porosity).

FIG. 1 Apparatus To Measure Engine Oil Filterability

6.9.1 *Air Regulator Tubing,* flexible tubing to prevent air from leaking from the air supply to the burette.

6.9.2 *Filter Holder Tubing,* flexible tubing used to connect burette tip to filter holder.

7. Reagents

7.1 *Purity of Reagents*—Use reagent grade chemicals in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society,[7] where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean Test Method D1193 Type III deionized water or water of equivalent purity.

7.3 *TMC Reference Oils*—These are available from the Test Monitoring Center.

8. Sampling

8.1 Take samples in accordance with the instructions in Practice D4057.

9. Preparation of Test Oil Sample and Filter

9.1 Determine the water treatment rate for the test and record it. Add the appropriate quantity of test oil and deionized water (see Table 1) to the blender for the desired water treatment rate, using the 1000 µL syringe.

9.2 Mix test oil and water in the blender for 30 s ± 1 s at 18 000 r⁄min ± 1800 r⁄min.

9.3 Add 49.7 g ± 0.1 g of test oil, 0.3 g ± 0.05 g of deionized water using the 1000 µL syringe to the blender, and mix for 30 s ± 1 s at 18 000 r⁄min ±10 %.

9.4 Repeat 9.3 with 49.5 g ± 0.1 g of test oil and 0.5 g ± 0.05 g water for 1 % water, 49.0 g ± 0.1 g of test oil and 1.0 g ± 0.05 g water for 2 % water, and 48.5 g ± 0.1 g of test oil and 1.5 g ± 0.05 g water for 3 % water.

9.5 Transfer the sample to a 60 mL wide-mouth glass jar and place the loosely capped (¼ turn) jar in an oven at 70.0 °C ± 1.0 °C for 6 h ±10 min. Remove from the oven, tighten cap, and allow to cool to room temperature 20 °C to 24 °C.

9.6 Store the sample in the dark at room temperature 20 °C to 24 °C.

9.7 Within 48 h ± 2 h of removing the sample from the oven, determine the filterability (see 10.2) of the sample.

9.8 Dry filters in an oven at 70 °C ± 2 °C for 30 min ± 2 min and store in a desiccator until used.

[7] *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.

10. Procedure

TABLE 1 Test Oil and Water Sample Quantities, by Water Treat Rate

Treatment Rate	Test Oil	Deionized Water
0.6 %	49.7 g ± 0.1 g	0.3 g ± 0.05 g
1.0 %	49.5 g ± 0.1 g	0.5 g ± 0.05 g
2.0 %	49.0 g ± 0.1 g	1.0 g ± 0.05 g
3.0 %	48.5 g ± 0.1 g	1.5 g ± 0.05 g

10.1 Assemble apparatus as shown in Fig. 1 with filter installed in proper orientation (25 µm smooth side up).

10.2 Determine the new oil flow rate by placing a sample of the new oil in the burette. Pressurize the system and force at least 10 mL of oil through the filter to saturate the filter with oil and remove any air bubbles. Disconnect the air line and fill the burette with new oil to a level 1 cm to 2 cm above the *0* mark. Pressurize the system to 69 kPa ± 2 kPa, open the stopcock, and measure the flow time for each successive 5 mL of oil between the 0 mL and 25 mL graduations.

10.3 To determine the test oil flow rate, the flow times of the new oil are first determined. Using the same filter disc, filter holder, and burette, reduce the new oil level in the burette to the lowest level that allows no air bubbles below the stopcock. Disconnect the air line and fill the burette with a well-mixed sample of test oil to a level 1 cm to 2 cm above the *0* mark. Pressurize the system to 69 kPa ± 2 kPa, open the stopcock, and measure the flow time for each successive 5 mL of oil between the 0 mL and 25 mL graduations.

10.4 Run each non-reference and reference oil in duplicate; repeat Section 9 and 10.1 to 10.4 for each non-reference and each reference oil.

10.5 For TMC-monitored tests, run the TMC reference oil on the same day as the non-reference oil.

10.6 For tests not monitored by the TMC, an in-house quality assurance oil can be used in place of the TMC reference.

11. Calculation

11.1 Calculate the flow rate for the new oil and the test oil for each 5 mL portion of oil using Eq 1:

$$FR = A/B \quad (1)$$

where:

FR = the flow rate of oil, mL/s,
A = volume of oil, mL, and
B = flow time, s.

11.2 Calculate the percent change in flow rate of the test oil relative to the new oil with the final oil flow rates (between 20 mL and 25 mL measured with the same filter disc) using Eq 2:

$$\Delta FR = 100(E - D)/D \quad (2)$$

where:

ΔFR = change in flow rate, %,
E = final test oil flow rate, mL/s, and