



Standard Test Method for Corrosiveness and Oxidation Stability of Hydraulic Oils, Aircraft Turbine Engine Lubricants, and Other Highly Refined Oils¹

This standard is issued under the fixed designation D4636; 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 Department of Defense.

^{e1} NOTE—Warning notes were editorially moved into the standard text in May 2004.

INTRODUCTION

This test method is the result of combining Federal Test Methods 5307.2 and 5308.7. Features and details of both of these test methods are included, but the new test method is basically **Method 5307.2** expanded to include **Method 5308.7**.

1. Scope

1.1 This test method covers the testing of hydraulic oils, aircraft turbine engine lubricants, and other highly refined oils to determine their resistance to oxidation and corrosion degradation and their tendency to corrode various metals. Petroleum and synthetic fluids may be evaluated using moist or dry air with or without metal test specimens.

1.2 This test method consists of a standard test procedure, an alternative Procedure 1, and an alternative Procedure 2. As there are variations possible with this test method, it will be up to the particular specification to establish the conditions required. In addition to temperature, the variables to specify if other than those of the standard procedure or alternative Procedure 1 or 2 are: test time, air flow and humidity, sample frequency, test fluid quantity, and metal specimen(s).

1.3 The values stated in SI units are to be regarded as standard. The values in parentheses are for information only.

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

2. Referenced Documents

2.1 ASTM Standards:²

D91 Test Method for Precipitation Number of Lubricating Oils

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

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

D1193 Specification for Reagent Water

D3339 Test Method for Acid Number of Petroleum Products by Semi-Micro Color Indicator Titration

2.2 U.S. Federal Test Method Standards:³

Method 5307.2 Corrosiveness and Oxidation Stability of Aircraft Turbine Engine Lubricants

Method 5308.7 Corrosiveness and Oxidation Stability of Light Oils (Metal Squares)

MIL-S-13282 Refined Silver (99.95) (P07015)

2.3 Other Standards:⁴

AMS 4616 Silicon Iron Bronze (C65900)

AMS 4908 Titanium Alloy—(8 % Mn) Annealed (R56080)

AMS 6490 Steel (M50) (T11350)

QQ-A-671 Cadmium Anod (L01900)

QQ-C-576 Copper Electrolytic Tough Pitch (ETP) (C11000)

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.09.0D on Oxidation of Lubricants.

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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 Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁴ See ASTM DS 56, Metal and Alloys in the Unified Numbering System.

QQ-M-44 Magnesium Alloy AZ31B Condition H24 or H26 (M11311)
 QQ-S-698 Low-Carbon Steel 1010, CR Temper No. 4 or 5 (G10100)
 QQ-A-250/4 Aluminum Alloy 2024 T-3 or T-4 (A92024)

3. Summary of Test Method

3.1 This test method consists of a standard test procedure (see 10.1), an alternative Procedure 1 (see 10.2), and an alternative Procedure 2 (see 10.3). The standard test procedure uses washer-shaped metal specimens stacked on the air tube, 200 mL of test oil, 10 L/h air flow rate, and periodic test oil withdrawal and evaluation. Alternative Procedure 1 uses washer-shaped metal specimens, 165 mL of test oil, 10 L/h air flow rate, and no periodic test oil sampling. Alternative Procedure 2 uses square metal specimens tied together resting vertically in the large glass tube, 100 mL of test oil, 5 L/h air flow rate, and no periodic test oil sampling.

NOTE 1—Flow rates other than those listed in this test method may be required by various specifications; if they are so used, the modification to the test method should be stated in the test report.

3.2 A large glass tube containing a sample of oil and metal specimens is placed in a constant temperature bath and heated for the specified number of hours while air is passed through the oil to provide agitation and a source of oxygen. Typically, temperatures of the bath used are from 100°C (212°F) to 360°C (680°F). Weighed metal specimens are placed in the tube during the test. Corrosiveness of the oil is determined by loss in metal mass, and microscopic examination of the sample metal surface(s). Oil samples are withdrawn from the test oil and checked for changes in viscosity and acid number as a result of the oxidation reactions.

3.3 Metals used in the basic test and alternative Procedure 1 are titanium, magnesium, steel (two types), bronze, silver, and aluminum. Metals used in alternative Procedure 2 are copper, steel, aluminum, magnesium, and cadmium. Other metals may be specified.

3.4 Sampling of the oil for analysis is done periodically throughout the test. Alternatively, no periodic samples are taken and a final viscosity and acid number are determined for comparison with those of the original untested oil.

3.5 At the end of the test, the amount of sludge present in the oil remaining in the same tube is determined by centrifugation. Also, the quantity of oil lost during the test is determined gravimetrically.

3.6 Air is used dry in the standard test. A humidifier may be used to provide controlled moist air, if required.

4. Significance and Use

4.1 This test method simulates the environment encountered by fully formulated lubricating fluids in actual service and uses an accelerated oxidation rate to permit measurable results to be obtained in a reasonable time. The use of metals provides catalytic reactive surfaces of those materials commonly found in real systems. The high temperature and air agitation help

accelerate the oxidation reactions that are expected to occur. Moisture in the air adds another realistic condition that encourages oil breakdown by facilitating acid formation.

4.2 Interpretation of results should be done by comparison with data from oils of known field performance. The accelerated conditions likely will cause one or more of the following measurable effects: mass change and corroded appearance of some metals; change of viscosity; increase in acid number; measurable reaction products in the form of sludge; and mass loss of oil due to evaporation.

4.3 This test method is most suitable for oils containing oxidation and corrosion inhibitors. Without such ingredient(s), the severe test conditions will yield rather drastic changes to the oil.

5. Apparatus

5.1 The main apparatus consists of the following items of standard wall borosilicate glassware as shown in Figs. 1-5:

5.1.1 *Main Sample Tube* (Fig. 1).

5.1.2 *Sample Tube Head* (Fig. 2).

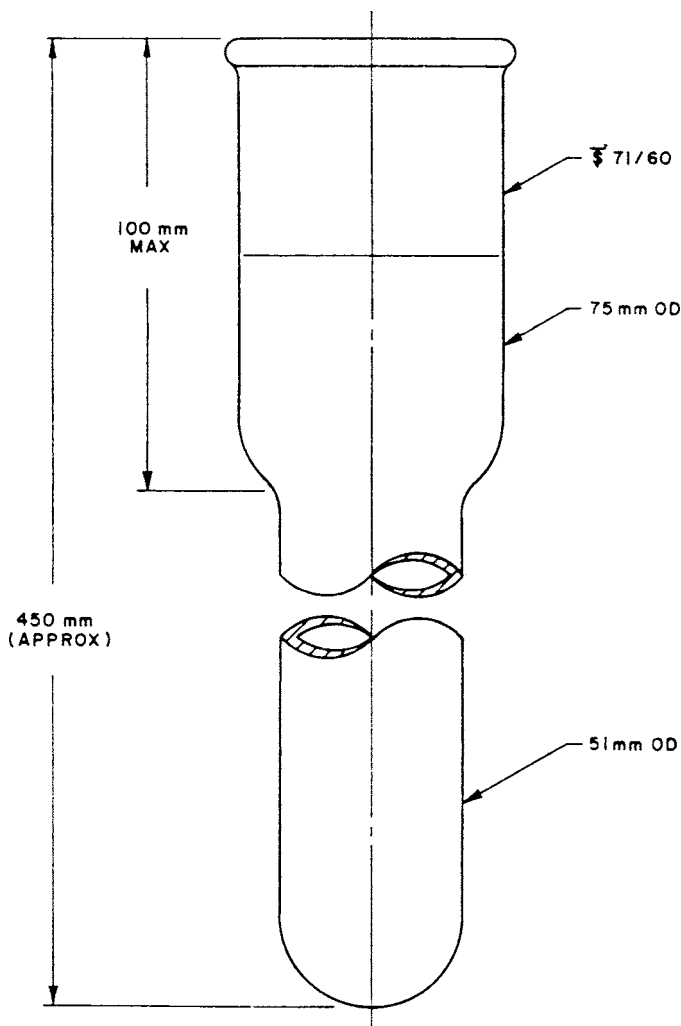


FIG. 1 Sample Tube

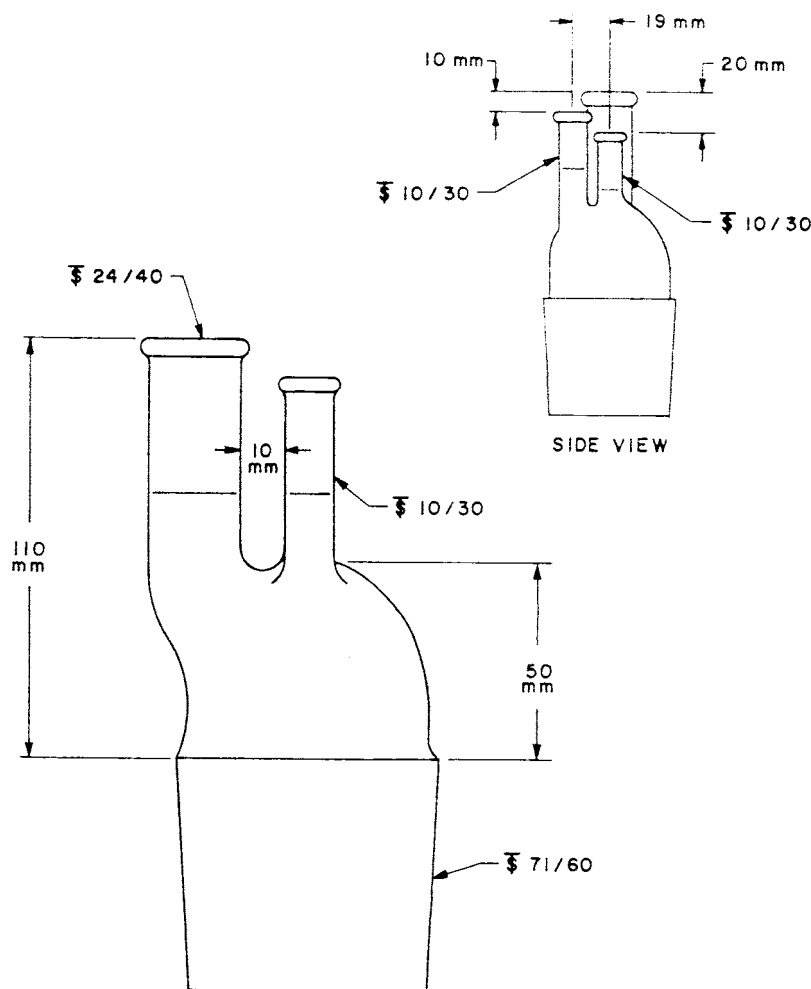


FIG. 2 Sample Tube Head

5.1.3 *Air Tube*⁵ (Fig. 3).

5.1.4 *Condenser, Allihn Type* (Fig. 4).

5.1.5 *Condenser, Allihn Type*, Fig. 4 with 71/60 joint.

5.1.6 *Assembled Apparatus* (Fig. 5).

5.2 Additional glassware items and assembly accessories needed are:

5.2.1 *Spacers (for Metal Specimen)*, of borosilicate glass, standard wall, 9-mm outside diameter, 6-mm length.

5.2.2 *Oil Sampling Tube, Borosilicate Glass*, 4-mm outside diameter, with sampling end approximately 600 mm to reach into the main sample tube. The tube is bent U-shape with exit end fitted by a one-hole stopper to a 25-mL filtering flask. The exit end may be any convenient length.

5.2.3 *Adapter*, polytetrafluoroethylene for 10/18 joint for sealing of air tube to sample tube head.

5.3 Other items and equipment are:

5.3.1 *Heating Bath*, constant temperature within $\pm 0.5^\circ\text{C}$ ($\pm 1^\circ\text{F}$) of test temperature with an immersion depth of 250 ± 20 mm. Oil baths or aluminum block baths are recommended, but above 220°C (428°F), use aluminum block bath or other similar non-oil-type heating medium. (**Warning**—There are

exposed hot surfaces on apparatus. Avoid contact with exposed skin by use of protective equipment as required.)

5.3.2 *Hood*, ventilation to adequately remove fumes during heating.

5.3.3 *Air Supply*, free of reactive contaminants. For dry air, dew point is -68°C (-90°F) maximum; for moist air, moisture is 10 ± 1 mg water/L air, standard conditions of 21°C (70°F)/105 kPa (1 atm).

5.3.4 *Flowmeter*, capable of measuring 10 ± 1 L/h at same standard conditions as in 5.3.3.

5.3.5 *Balance*, analytical, sensitivity 0.1 mg.

5.3.6 *Balance, Laboratory*, 2500-g capacity, 0.1-g sensitivity.

5.3.7 *Centrifuge*, capable of relative force of 840 ± 40 relative centrifugal force at the tip of the tubes.

5.3.8 *Centrifuge Tubes*, Test Method D91, cone-shaped, 100 mL.

5.3.9 *Microscope*, with 20-diameter magnification.

5.3.10 *Assembly Fixture*, wood (slotted to hold metal squares for tying with cord) as shown in Fig. 6.

5.3.11 *Cord or Wire*, for tying metal squares together. Suitable cord should be lightweight of cleaned linen, cotton, nylon, or ceramic fiber; suitable wire is of stainless steel.

⁵ An 800-mm air tube may be used for alternate Procedure 1 or 2 when using the condenser as opposed to the sample tube head in the standard procedure.