Designation: D5846 – 07 (Reapproved 2012)

# Standard Test Method for Universal Oxidation Test for Hydraulic and Turbine Oils Using the Universal Oxidation Test Apparatus[1]

This standard is issued under the fixed designation D5846; 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 a procedure for evaluating the oxidation stability of petroleum base hydraulic oils and oils for steam and gas turbines.

1.2 This test method was developed to evaluate the oxidation stability of petroleum base hydraulic oils and oils for steam and gas turbines.

1.2.1 Rust and oxidation inhibited hydraulic, anti-wear hydraulic and turbine oils of ISO 32–68 viscosity were used to develop the precision statement. This test method has been used to evaluate the oxidation stability of fluids made with synthetic basestock and in-service oils; however, these fluids have not been used in cooperative testing to develop precision data.

1.3 The values stated in SI units are to be regarded as standard. The values given 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.* Identified hazardous chemicals are listed in 7.3, 7.6, and 7.8. Before using this test method, refer to suppliers' safety labels, Material Safety Data Sheets, and other technical literature.

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

A510 Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

B1 Specification for Hard-Drawn Copper Wire

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

D943 Test Method for Oxidation Characteristics of Inhibited Mineral Oils

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

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

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4740 Test Method for Cleanliness and Compatibility of Residual Fuels by Spot Test

D4871 Guide for Universal Oxidation/Thermal Stability Test Apparatus

D5770 Test Method for Semiquantitative Micro Determination of Acid Number of Lubricating Oils During Oxidation Testing

2.2 *Energy Institute Standard:*[3]

IP 2546 Practice for Sampling of Petroleum Products; alternate to Practice D4057

2.3 *British Standard:*[4]

BS 1829 Specification for Carbon Steel Wire; alternate to Specification A510

2.4 *ASTM Adjuncts:*

Reference Spot Sheet[5]

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *inhibited mineral oil, n*—a petroleum oil containing additives to retard oxidation.

3.1.2 *oxidation life, n*—of an oil, the time in hours required for degradation of the oil under test.

3.1.3 *universal oxidation test, n*—the apparatus and procedures described in Guide D4871.

[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.

Current edition approved Dec. 1, 2012. Published December 2012. Originally approved in 1995. Last previous edition approved in 2007 as D5846–07. DOI: 10.1520/D5846-07R12.

[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 Energy Institute, 61 New Cavendish St., London, WIG 7AR, U.K., http://www.energyinst.org.uk.

[4] Available from British Standards Institute (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., http://www.bsi-global.com.

[5] Available from ASTM International Headquarters. Order Adjunct No. ADJD4740. Original adjunct produced in 2000.

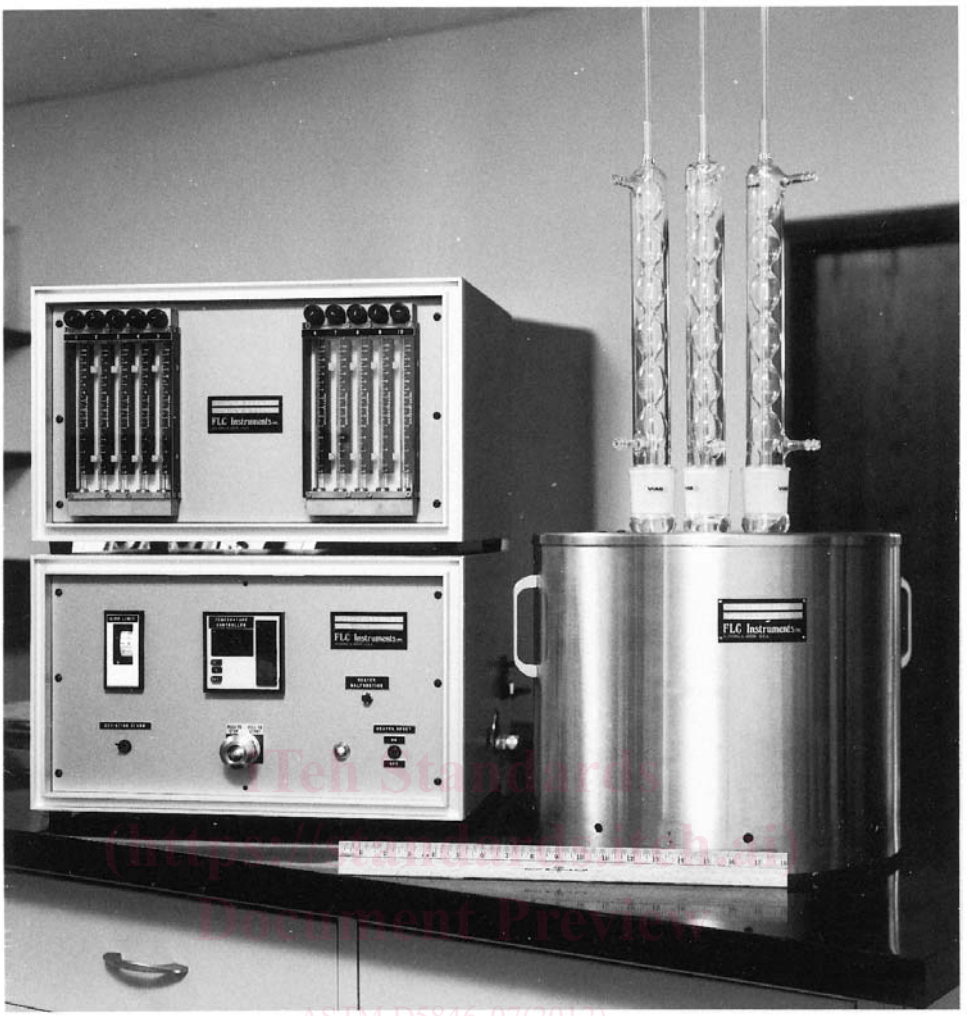


FIG. 1 Apparatus, Showing Gas Flow Control System, Temperature Control System, and Heating Block



## 4. Summary of Test Method

4.1 An oil sample is contacted with air at 135°C in the presence of copper and iron metals. The acid number and spot forming tendency of the oil are measured daily. The test is terminated when the oxidation life of the oil has been reached.

4.2 The oil is considered to be degraded when either its acid number (measured by Test Methods D974 or D664) has increased by 0.5 mg KOH/g over that of new oil; or when the oil begins to form insoluble solids so that when a drop of oil is placed onto a filter paper it shows a clearly defined dark spot surrounded by a ring of clear oil.

## 5. Significance and Use

5.1 Degradation of hydraulic fluids and turbine oils, because of oxidation or thermal breakdown, can result in the formation of acids or insoluble solids and render the oil unfit for further use.

5.2 This test method can be used to estimate the relative oxidation stability of petroleum-base oils. It should be recognized that correlation between results of this test and the oxidation stability in use can vary markedly with service conditions and with various oils.

## 6. Apparatus

6.1 *Heating Block,* as shown on the right in Fig. 1, and as further described in Guide D4871, to provide a controlled constant temperature for conducting the test.

6.1.1 Test cells are maintained at a constant elevated temperature by means of a heated aluminum block which surrounds each test cell.

6.1.2 The test cells shall fit into the block to a depth of 225 ± 5 mm. When centered, the side clearance of the 38 mm outside diameter glass tube to the holes in the aluminum block shall not exceed 1 mm in any direction.

6.2 *Temperature Control System,* as shown at lower left in Fig. 1, and as further described in Guide D4871, to maintain the test oils in the heating block at 135 ± 0.5°C for the duration of the test.

6.3 *Gas Flow Control System,* as shown in the upper left in Fig. 1, and as further described in Guide D4871, to provide dry air at a flow rate of 3.0 ± 0.5 L/h to each test cell.

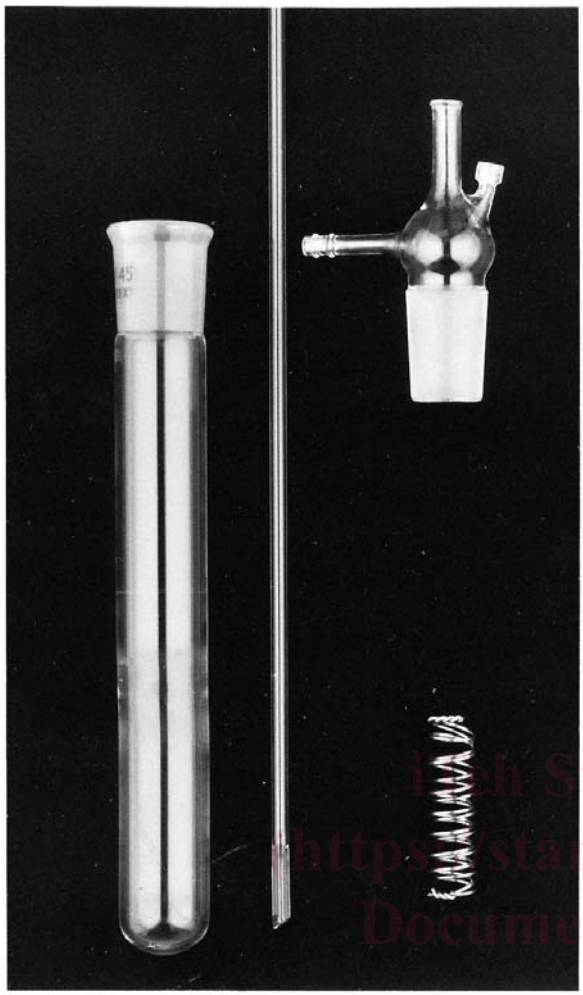

**FIG. 2 Test Cell, Including Oxidation Cell, Gas Inlet Tube, Basic Head, and Finished Catalyst Coil**

6.3.1 A gas flow controller is required for each test cell.

6.3.2 Flowmeters shall have a scale length sufficiently long to permit accurate reading and control to within 5 % of full scale.

6.3.3 The total system accuracy shall meet or exceed the following tolerances: Inlet pressure regulator within 0.34 kPa (0.05 psig) of setpoint; total flow control system reproducibility within 7 % of full scale; repeatability of measurement within 0.5 % of full scale.

6.4 *Oxidation Cell,* borosilicate glass, as shown in Fig. 2, and as further described in Guide D4871. This consists of a test cell of borosilicate glass, standard wall; 38 mm outside diameter, 300 ± 5-mm length, with open end fitted with a 34/45 standard-taper, ground-glass outer joint.

6.5 *Gas Inlet Tube,* as shown in Fig. 2, and as further described in Guide D4871. This consists of an 8-mm outside diameter glass tube, at least 455 long, lower end with fused capillary 1.5 to 3.5 mm inside diameter. The capillary bore shall be 15 ± 1 mm long. The lower tip is cut at a 45° angle.

6.6 *Basic Head,* as shown in Fig. 2, and as further described in Guide D4871. This is an air condenser, with 34/45 standard-taper, ground-glass inner joint, opening for gas inlet tube, septum port for sample withdrawal, and exit tube to conduct off-gases and entrained vapors. Overall length shall be 125 ± 5 mm.

6.7 Test precision was developed using the universal oxidation/thermal stability test apparatus described in Guide D4871.[6,7] Alternate apparatus designs for sample heating and for temperature and flow control shall be acceptable provided they are shown to maintain temperature and gas flow within the specified limits.

## 7. Reagents and Materials

7.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[8] 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 *Abrasive Cloth,* silicon carbide, 100-grit with cloth backing.

7.3 *Acetone,* reagent grade. (**Warning—**Acetone is flammable and a health hazard.)

7.4 *Air,* dry with dew point −60°.

7.5 *Electrolytic Copper Wire,* 1.63 mm in diameter (No. 14 American Wire Gage or No. 16 Imperial Standard Wire Gage), 99.9 % purity, conforming to Specification B1, is preferred.

7.6 *Heptane,* knock-test grade, conforming to the following requirements: (**Warning—***n*—Heptane is flammable and a health hazard.)

| | |
|---|---|
| Density at 20°C | 0.6826 to 0.6839 |
| Refractive index at 20°C | 1.3876 to 1.3879 |
| Solidification temperature, min | −90.72° |
| Distillation | 50 % shall distill between 98.38° and 98.48°. Temperature rise between 20 and 80 % recovered shall be 0.20° max |

7.7 *Low-Metalloid Steel Wire,* 1.59 mm in diameter (No. 16 Washburn and Moen Gage). Carbon steel wire, soft bright annealed and free from rust, of Grade 1008 as described in Specification A510, is preferred. Similar wire conforming to British Standard 1829 is also satisfactory.

7.8 *Propanol-2 (iso-Propyl Alcohol),* reagent grade. (**Warning—***iso*-Propyl alcohol is flammable and a health hazard.)

[6] The sole source of supply of the apparatus, including heating block, temperature control system, and flow control system, known to the committee at this time is Falex Corp., 1020 Airpark Dr., Sugar Grove, IL 60554. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters.

[7] 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.

[8] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For Suggestions on the testing of reagents not listed by the American Chemical Society, see *Annual 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.