



Standard Test Method for Air Release Properties of Petroleum Oils¹

This standard is issued under the fixed designation D 3427; 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 ability of turbine, hydraulic, and gear oils to separate entrained air.

NOTE 1—This test method was developed for mineral based oils. It may be used for some synthetic fluids; however, the precision statement applies only to petroleum oils.

1.2 *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:

D 329 Specification for Acetone²

D 1193 Specification for Reagent Water³

D 1401 Test Method for Water Separability of Petroleum Oils and Synthetic Fluids⁴

E 1 Specification for ASTM Thermometers⁵

2.2 DIN Standard:⁶

DIN 51 381

3. Terminology

3.1 Definition of Term Specific to This Standard:

3.1.1 *air release time, n*—the number of minutes needed for air entrained in the oil to reduce in volume to 0.2 % under the conditions of this test and at the specified temperature.

4. Summary of Test Method

4.1 Compressed air is blown through the test oil, which has been heated to a temperature of 25, 50, or 75°C. After the air flow is stopped, the time required for the air entrained in the oil to reduce in volume to 0.2 % is recorded as the air release time.

5. Significance and Use

5.1 Agitation of lubricating oil with air in equipment, such as bearings, couplings, gears, pumps, and oil return lines, may produce a dispersion of finely divided air bubbles in the oil. If the residence time in the reservoir is too short to allow the air bubbles to rise to the oil surface, a mixture of air and oil will circulate through the lubricating oil system. This may result in an inability to maintain oil pressure (particularly with centrifugal pumps), incomplete oil films in bearings and gears, and poor hydraulic system performance or failure.

5.2 This test method measures the time for the entrained air content to fall to the relatively low value of 0.2 % volume under a standardized set of test conditions and hence permits the comparison of the ability of oils to separate entrained air under conditions where a separation time is available. The significance of this test method has not been fully established. However, entrained air can cause sponginess and lack of sensitivity of the control of turbine and hydraulic systems. This test may not be suitable for ranking oils in applications where residence times are short and gas contents are high.

6. Apparatus

6.1 A schematic diagram of the apparatus is shown in Fig. 1. The component parts are described as follows:

6.1.1 *Test Vessel*, made of borosilicate glass as shown in Fig. 2, consisting of a jacketed sample tube fitted with an air inlet capillary, baffle plate, and air outlet tube. The two parts of each test vessel should be marked and preferably used as a pair. Interchanged parts may be used so long as the resultant test vessel conforms to the stated dimensions.

6.1.2 *Pressure Gage*, covering the range from 0 to 35 kPa, with divisions at least every 2 kPa, and an accuracy of 1.5 kPa.

6.1.3 Thermometers:

6.1.3.1 *Air Thermometer*, for measuring compressed air temperature. ASTM Precision Thermometer having a range from –20 to 102°C, graduated in 0.2°C and conforming to the requirements for Thermometer 12C as prescribed in Specification E 1 is suitable. A temperature sensor of at least equivalent performance is also suitable. Care shall be taken to avoid restricting the air path with the thermometer bulb or any adapter used.

6.1.3.2 *Sample Thermometer*, for measuring the temperature of the sample during preparation and trial runs. ASTM Precision Thermometer having a range from –20 to 102°C,

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.C0.02 on Corrosion and Water/Air Separability.

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² *Annual Book of ASTM Standards*, Vol 06.04.

³ *Annual Book of ASTM Standards*, Vol 11.01.

⁴ *Annual Book of ASTM Standards*, Vol 05.01.

⁵ *Annual Book of ASTM Standards*, Vol 14.03.

⁶ Available from Beuth Verlag GmbH, Burggrafenstrasse 6, 1000 Berlin 30, Germany.

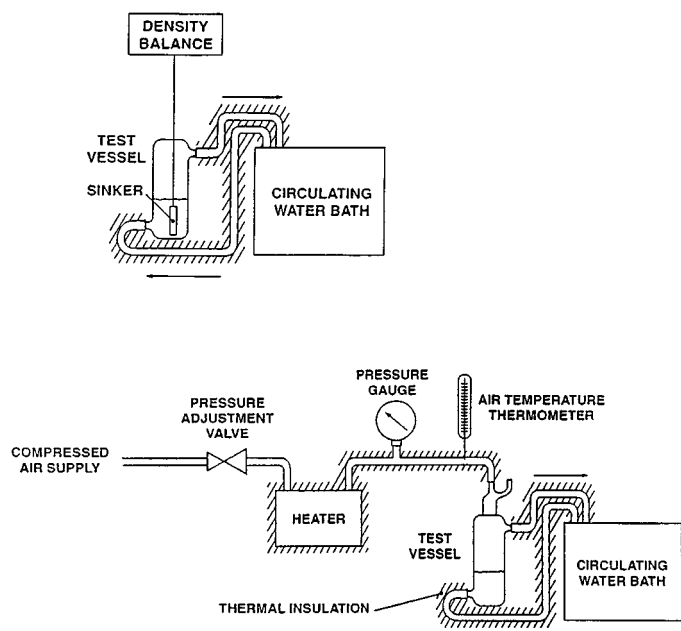


FIG. 1 Apparatus for the Determination of Air Release Time

graduated in 0.2°C and conforming to the requirements for Thermometer 12C as prescribed in Specification E 1 is suitable. A temperature sensor of at least equivalent performance is also suitable.

6.1.4 *Heater*, to bring the compressed air up to measurement temperature. A coil of copper tubing immersed in the circulating bath (see 6.1.5) is suitable at 25°C, but additional heating is necessary at 50 and 75°C. This can be obtained by an additional bath, or by using a separate steam or electric heat exchanger. The temperature of the air shall be measured by a thermometer located as close as possible to the testing vessel and meeting the specifications shown in 6.1.3.

NOTE 2—The application of thermal insulation to the pipework carrying the heated compressed air is recommended.

6.1.5 *Circulating Bath*, approximately 10-L capacity with a rate of flow of 10 L/min and capable of maintaining the test cell at a temperature of 25, 50, or 75°C within $\pm 0.1^\circ\text{C}$.

NOTE 3—Use of water in the bath has been found to minimize electrostatic effects.

NOTE 4—The application of thermal insulation to the pipework carrying the heated bath fluid is recommended.

(Warning—The use of glass vessels with glass host fittings for circulating 75°C (167°F) bath medium is potentially dangerous. Back pressure in excess of a gage pressure of 70 kPa (10 psi) can be generated when oil is pumped at the required rate; this can cause fracture of the glass or slippage of the hose connections. Use of a pressure relief valve set at 70 kPa (10 psi) is recommended. In addition, use of a safety shield is recommended.)

6.2 *Balance*, capable of measuring density, accurate to 0.5 kg/m³.

6.3 *Sinker*, having a round or tapered bottom of 5 or 10-mL displacement, 80.0 \pm 1.5-mm length. If the sinker contains a thermometer, it shall be usable between 25 and 75°C.

6.4 *Oven*, capable of heating samples to 10°C above the test temperature.

6.5 *Timer*, readable to 0.1 min, with an accuracy of better than 0.1 %.

6.6 *Pump*, with a nonpulsating output and capable of maintaining an air flow of 40 L/min at a pressure of 20 kPa (optional, see 7.4).

7. Materials

7.1 *Purity of Reagents*—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.⁷ 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*—Reagent water as defined by Type II of Specification D 1193.

7.3 *Acetone*, conforming to Specification D 329. **(Warning—**Flammable. Health hazard.)

7.4 *Air, Compressed*, dry and free from moisture, particulates, and oil. Air from a cylinder or a nonpulsating pump may be used. **(Warning—**Compressed gas under high pressure.)

7.5 *Cleaning Reagent*, Cleaning either in hot Nochromix⁸ **(Warning: Corrosive health hazard oxidizer)**, or a 24-h soak at room temperature in Micro⁹ solution.

NOTE 5—Previously, chrome sulfuric acid was used in this procedure. Other test methods (for example, Test Method D 1401) have demonstrated acceptable, statistically equivalent results when Nochromix or Micro is used to replace sulfuric chromic acid for cleaning.

7.6 *n-Heptane*, reagent grade. **(Warning—**Flammable. Harmful if inhaled.)

8. Preparation of Apparatus

8.1 Clean the interior of the test vessel, including the air inlet and sinker, and all other glassware coming in contact with the sample, before each determination in the following manner:

8.1.1 Rinse away the oil residue with *n*-heptane **(Warning—**see 7.6) and acetone **(Warning—**see 7.3) and dry by air blowing.

8.1.2 Clean the apparatus by immersing in cleaning reagent in order to remove completely any traces of silicone.

8.1.3 Rinse with reagent water.

8.1.4 Rinse with acetone **(Warning—**see 7.3) and dry with clean compressed air **(Warning—**see 7.4).

NOTE 6—Oil misting occurs during blowing. The test vessel should be in a hood, or the air outlet tube should be connected to a vent that removes the vapors.

9. Procedure

9.1 Assemble the test apparatus as shown in Fig. 1. Set the

⁷ *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 *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopoeia and National Formulary*, U.S. Pharmacopoeial Convention, Inc. (USPC), Rockville, MD.

⁸ Nochromix is available from Godax Laboratories, Inc., 720-B Erie Ave., Takoma Park, MD 20912.

⁹ Micro is available from International Products Corp., P.O. Box 70, Burlington, NJ 08016.