Designation: ~~D189 – 06 (Reapproved 2014)~~ D189 – 06 (Reapproved 2019) British Standard 4380

Standard Test Method for Conradson Carbon Residue of Petroleum Products[1]

This standard is issued under the fixed designation D189; 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 U.S. Department of Defense.

1. Scope

1.1 This test method covers the determination of the amount of carbon residue (Note 1) left after evaporation and pyrolysis of an oil, and is intended to provide some indication of relative coke-forming propensities. This test method is generally applicable to relatively nonvolatile petroleum products which partially decompose on distillation at atmospheric pressure. Petroleum products containing ash-forming constituents as determined by Test Method D482 or IP Method 4 will have an erroneously high carbon residue, depending upon the amount of ash formed (Note 2 and Note 4).

NOTE 1—The term *carbon residue* is used throughout this test method to designate the carbonaceous residue formed after evaporation and pyrolysis of a petroleum product under the conditions specified in this test method. The residue is not composed entirely of carbon, but is a coke which can be further changed by pyrolysis. The term *carbon residue* is continued in this test method only in deference to its wide common usage.

NOTE 2—Values obtained by this test method are not numerically the same as those obtained by Test Method D524. Approximate correlations have been derived (see Fig. X1.1), but need not apply to all materials which can be tested because the carbon residue test is applied to a wide variety of petroleum products.

NOTE 3—The test results are equivalent to Test Method D4530, (see Fig. X1.2).

NOTE 4—In diesel fuel, the presence of alkyl nitrates such as amyl nitrate, hexyl nitrate, or octyl nitrate causes a higher residue value than observed in untreated fuel, which can lead to erroneous conclusions as to the coke forming propensity of the fuel. The presence of alkyl nitrate in the fuel can be detected by Test Method D4046.

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 **WARNING**—Mercury has been designated by many regulatory agencies as a hazardous material that can cause central nervous system, kidney and liver damage. Mercury, or its vapor, may be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury containing products. See the applicable product Material Safety Data Sheet (MSDS) for details and EPA's ~~website—http://www.epa.gov/mercury/faq.htm—for~~ website—http://www.epa.gov/mercury/faq.htm—for additional information. Users should be aware that selling mercury and/or mercury containing products into your state or country may be prohibited by law.

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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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]

D482 Test Method for Ash from Petroleum Products

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[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 D02.06 on Analysis of Liquid Fuels and Lubricants.

Current edition approved ~~Oct. 1, 2014~~Dec. 1, 2019. Published ~~November 2014~~December 2019. Originally approved in 1924. Last previous edition approved in ~~2010~~2014 as D189 – 06 ~~(2010)~~(2014).~~ε1~~. DOI: ~~10.1520/D0189-06R14.~~10.1520/D0189-06R19.

In the IP, this test method is under the jurisdiction of the Standardization Committee and is issued under the fixed designation IP 13. The final number indicates the year of last revision. This test method was adopted as a joint ASTM–IP standard in 1964.

This procedure is a modification of the original Conradson method and apparatus for Carbon Test and Ash Residue in Petroleum Lubricating Oils. See *Proceedings*, Eighth International Congress of Applied Chemistry, New York, Vol 1, p. 131, September 1912; also *Journal of Industrial and Engineering Chemistry*, IECHA, Vol 4, No. 11, December 1912.

In 1965, a new Fig. 2 on reproducibility and repeatability combining ASTM and IP precision data replaced old Fig. 2 and Note 4.

[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.

D524 Test Method for Ramsbottom Carbon Residue of Petroleum Products
D4046 Test Method for Alkyl Nitrate in Diesel Fuels by Spectrophotometry (Withdrawn 2019)[3]
D4057 Practice for Manual Sampling of Petroleum and Petroleum Products
D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants
D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products
D4530 Test Method for Determination of Carbon Residue (Micro Method)
E1 Specification for ASTM Liquid-in-Glass Thermometers
E133 Specification for Distillation Equipment

3. Terminology

3.1 *Definitions:*

3.1.1 *carbon residue, n*—the residue formed by evaporation and thermal degradation of a carbon containing material.

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

3.1.1.1 *Discussion*—

The residue is not composed entirely of carbon but is a coke that can be further changed by carbon pyrolysis. The term carbon residue is retained in deference to its wide common usage. ~~D4175~~ **D4175**

4. Summary of Test Method

4.1 A weighed quantity of sample is placed in a crucible and subjected to destructive distillation. The residue undergoes cracking and coking reactions during a fixed period of severe heating. At the end of the specified heating period, the test crucible containing the carbonaceous residue is cooled in a desiccator and weighed. The residue remaining is calculated as a percentage of the original sample, and reported as Conradson carbon residue.

5. Significance and Use

5.1 The carbon residue value of burner fuel serves as a rough approximation of the tendency of the fuel to form deposits in vaporizing pot-type and sleeve-type burners. Similarly, provided alkyl nitrates are absent (or if present, provided the test is performed on the base fuel without additive) the carbon residue of diesel fuel correlates approximately with combustion chamber deposits.

5.2 The carbon residue value of motor oil, while at one time regarded as indicative of the amount of carbonaceous deposits a motor oil would form in the combustion chamber of an engine, is now considered to be of doubtful significance due to the presence of additives in many oils. For example, an ash-forming detergent additive may increase the carbon residue value of an oil yet will generally reduce its tendency to form deposits.

5.3 The carbon residue value of gas oil is useful as a guide in the manufacture of gas from gas oil, while carbon residue values of crude oil residuums, cylinder and bright stocks, are useful in the manufacture of lubricants.

6. Apparatus (see Fig. 1)

6.1 *Porcelain Crucible,* wide form, glazed throughout, or a silica crucible; ~~29-~~29 mL to ~~31-mL~~31 mL capacity, ~~46~~46 mm to ~~49 mm~~ 49 mm in rim diameter.

6.2 *Iron Crucible*—Skidmore iron crucible, flanged and ringed, ~~65-~~65 mL to ~~82-mL~~82 mL capacity, ~~53~~53 mm to ~~57 mm~~ 57 mm inside and ~~60-~~60 mm to ~~67-mm~~67 mm outside diameter of flange, ~~37~~37 mm to ~~39 mm~~ 39 mm in height supplied with a cover without delivery tubes and having the vertical opening closed. The horizontal opening of about ~~6.5 mm~~ 6.5 mm shall be kept clean. The outside diameter of the flat bottom shall be ~~30~~30 mm to ~~32 mm.~~32 mm.

6.3 *Iron Crucible*—Spun sheet-iron crucible with cover; ~~78~~78 mm to ~~82 mm~~ 82 mm in outside diameter at the top, ~~58~~58 mm to ~~60 mm~~ 60 mm in height, and approximately ~~0.8 mm~~ 0.8 mm in thickness. Place at the bottom of this crucible, and level before each test, a layer of about ~~25 mL~~ 25 mL of dry sand, or enough to bring the Skidmore crucible, with cover on, nearly to the top of the sheet-iron crucible.

6.4 *Wire Support*—Triangle of bare Nichrome wire of approximately No. 13 B & S gage having an opening small enough to support the bottom of the sheet-iron crucible at the same level as the bottom of the heat-resistant block or hollow sheet-metal box (6.6).

6.5 *Hood*—Circular sheet-iron hood from ~~120~~120 mm to ~~130 mm~~ 130 mm in diameter the height of the lower perpendicular side to be from ~~50~~50 mm to ~~53 mm;~~ 53 mm; provided at the top with a chimney ~~50~~50 mm to ~~60 mm~~ 60 mm in height and ~~50~~50 mm to ~~56 mm~~ 56 mm in inside diameter, which is attached to the lower part having the perpendicular sides by a cone-shaped member,

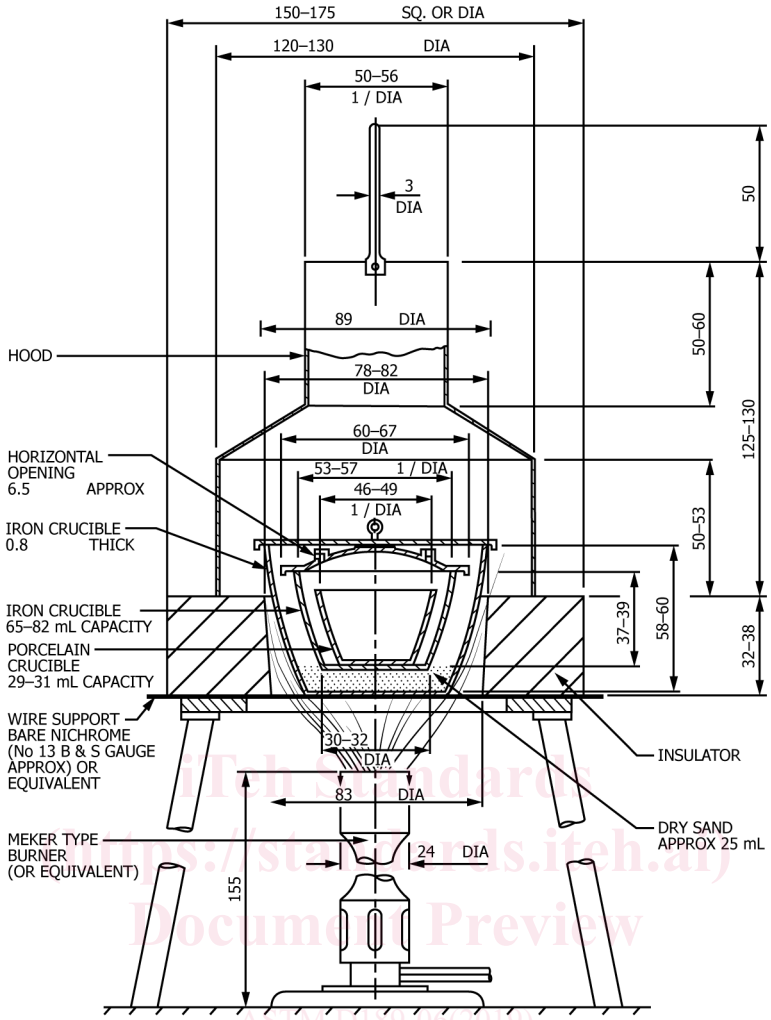

FIG. 1 Apparatus for Determining Conradson Carbon Residue

bringing the total height of the complete hood to ~~125~~125 mm to ~~130 mm.~~ 130 mm. The hood can be made from a single piece of metal, provided it conforms to the foregoing dimensions. As a guide for the height of the flame above the chimney, a bridge made of approximately ~~3 mm~~3 mm iron or Nichrome wire, and having a height of ~~50 mm~~ 50 mm above the top of the chimney, shall be attached.

6.6 *Insulator*—Heat-resistant block, refractory ring, or hollow sheet-metal box, ~~150~~150 mm to ~~175 mm~~ 175 mm in diameter if round, or on a side if square, ~~32~~32 mm to ~~38 mm~~ 38 mm in thickness, provided with a metal-lined, inverted cone-shaped opening through the center; ~~83 mm~~ 83 mm in diameter at the bottom, and ~~89 mm~~ 89 mm in diameter at the top. In the case of the refractory ring no metal lining is necessary, providing the ring is of hard, heat-resistant material.

NOTE 5—It is not know what type of insulators were used in the round robin conducted for obtaining the precision given in Section 13.

6.7 *Burner,* Meker type, having an orifice approximately ~~24 mm~~ 24 mm in diameter.

7. Sampling

7.1 For sampling techniques see Practices D4057 and D4177.

8. Procedure

8.1 Shake thoroughly the sample to be tested, first heating to ~~50°~~50 °C ± ~~10°C~~10 °C for ~~0.5 h~~ 0.5 h when necessary to reduce its viscosity. Immediately following the heating and shaking, filter test portion through a 100 mesh screen. Weigh to the nearest ~~5 mg~~ 5 mg a ~~10 g~~10 g sample of the oil to be tested, free of moisture and other suspended matter, into a tared porcelain or silica crucible containing two glass beads about ~~2.5 mm~~ 2.5 mm in diameter. Place this crucible in the center of the Skidmore crucible. Level the sand in the large sheet-iron crucible and set the Skidmore crucible on it in the exact center of the iron crucible. Apply covers to both the Skidmore and the iron crucible, the one on the latter fitting loosely to allow free exit to the vapors as formed.