



## Designation: ~~D2709 – 96 (Reapproved 2011)~~<sup>ε1</sup> D2709 – 16

# Standard Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge<sup>1</sup>

This standard is issued under the fixed designation D2709; 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 ( $\epsilon$ ) 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.*

<sup>ε1</sup> NOTE—Added part of speech to term in 3.1.1 editorially in May 2011.

## 1. Scope—Scope\*

1.1 This test method covers the determination of the volume of free water and sediment ~~in (as a percentage of the sample) that is suspended in the bulk fuel in middle distillate fuels having viscosities at 40°C (104°F) with viscosities in the range of 1.0 to 4.1 mm<sup>2</sup>/s (1.0 to 4.1 cSt) at 40 °C (1.0 cSt to 4.1 cSt at 104 °F) and densities in the range of 770 to 900 kg/m<sup>3</sup> (770 to 900 kg/m<sup>3</sup> at 15 °C).~~ in (as a percentage of the sample) that is suspended in the bulk fuel in middle distillate fuels having viscosities at 40°C (104°F) with viscosities in the range of 1.0 to 4.1 mm<sup>2</sup>/s (1.0 to 4.1 cSt) at 40 °C (1.0 cSt to 4.1 cSt at 104 °F) and densities in the range of 770 to 900 kg/m<sup>3</sup> (770 to 900 kg/m<sup>3</sup> at 15 °C).

NOTE 1—Fuels corresponding to Specification D396 Grades No. 1 and 2, D975 Grades ~~1D~~No. 1-D and ~~2D~~2-D, Specification D2880 Grades No. 0-GT, 1-GT and 2-GT, and Specification D3699 Grades No. 1-K and 2-K and similar middle distillate fuels and blendstocks will usually fall in this viscosity and density range. Test Method D1796 is intended for higher viscosity fuel oils.

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

1.2.1 Exception—The non-SI values are for information only.

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

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

D396 Specification for Fuel Oils

D975 Specification for Diesel Fuel Oils

D1796 Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure)

D2880 Specification for Gas Turbine Fuel Oils

D3699 Specification for Kerosine

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

## 3. Terminology

3.1 For definitions of terms used in this test method, refer to Terminology D4175.

3.2 *Definitions of Terms Specific to This Standard:* Definitions:

3.2.1 distillate fuel, free water, n—~~a virgin or cracked or blend of virgin and cracked distillate having a flash point greater than 38°C. water in excess of that soluble in the fuel at the temperature of the test and appearing in the fuel as a haze, cloudiness, droplets, or water layer.~~ a virgin or cracked or blend of virgin and cracked distillate having a flash point greater than 38°C. water in excess of that soluble in the fuel at the temperature of the test and appearing in the fuel as a haze, cloudiness, droplets, or water layer.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum ~~Products—Products, Liquid Fuels, and Lubricants~~ and is the direct responsibility of Subcommittee D02.14 on Stability and Cleanliness of Liquid Fuels.

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<sup>2</sup> 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.

### 3.2.1.1 Discussion—

\*A Summary of Changes section appears at the end of this standard

**TABLE 1 Rotation Speeds Applicable for Centrifuges of Various Diameters of Swing**

Diameters of Swing <sup>A</sup>		Rpm at 500	Rpm at 800
in.	cm	rcf	ref
12	30.5	1710	2160
13	33.0	1650	2080
14	35.6	1590	2000
15	38.1	1530	1930
16	40.6	1480	1870
17	43.2	1440	1820
18	45.7	1400	1770
19	48.3	1360	1720
20	50.8	1330	1680
21	53.3	1300	1640
22	55.9	1270	1600
23	58.4	1240	1560
24	61.0	1210	1530

**TABLE 1 Rotation Speeds Applicable for Centrifuges of Various Diameters of Swing**

Diameter of Swing <sup>A</sup>		r/min <sup>B</sup> at 800
in.	cm	rcf
12	30.5	2160
13	33.0	2080
14	35.6	2000
15	38.1	1930
16	40.6	1870
17	43.2	1820
18	45.7	1770
19	48.3	1720
20	50.8	1680
21	53.3	1640
22	55.9	1600
23	58.4	1560
24	61.0	1530

<sup>A</sup> Measured between tips of opposite tubes when in rotating position.

<sup>B</sup> "r/min" is the correct SI symbol for the former term "rpm."

Note that when there is a water layer in a biodiesel fuel blend, there can be water-soluble components present in the free water.

### 3.3 Abbreviations:

3.3.1 *rcf*—relative centrifugal force.

## 4. Summary of Test Method

4.1 A ~~100-mL~~ 100 mL sample of the undiluted fuel is centrifuged at a relative centrifugal force (see 6.2) of 800 for ~~10 min~~ 10 min at ~~21 to 32°C (70 to 90°F)~~ 21 to 32°C (70 to 90°F) in a centrifuge tube readable to 0.005 mL and measurable to 0.01 mL, specified centrifuge tube. After centrifugation, the volume of free water and sediment which that has settled into the tip of the centrifuge tube is read to the nearest ~~0.005 mL~~ 0.005 mL and reported as the volumetric percent water and sediment by centrifuge.

## 5. Significance and Use

5.1 This test method is used as an indication of free water and sediment suspended as haze, cloudiness, or droplets in middle distillate fuels such as Grade Nos. Grades No. 1 and 2 fuel oil (Specification D396), Nos. Grades No. 1-D and 2-D diesel fuel (Specification D975), and Nos. Grades No. 0-GT, 1-GT, and 2-GT gas turbine fuels (Specification D2880), similar fuels and blendstocks used to make these fuels.

5.2 Appreciable amounts of free water and sediment in a fuel oil tend to cause fouling of the fuel-handling facilities and to give trouble in the fuel system of a burner or engine. An accumulation of sediment in storage tanks and on filter screens can obstruct the flow of oil from the tank to the combustor. ~~Water-Free water~~ Free water in middle distillate fuels can cause corrosion of tanks and equipment, and if detergent is present, the water can cause emulsions or a hazy appearance. ~~Water is necessary to~~ Free water can support microbiological growth at ~~fuel-water interfaces~~ fuel-water interfaces in fuel systems.

## 6. Apparatus

6.1 Centrifuge, capable of ~~whirling two~~ spinning one or more pairs of filled centrifuge tubes at a speed which can be controlled to give a relative centrifugal force (rcf) of 800 ± 60 at the tip of the tubes. The revolving head, trunnion rings, and trunnion cups, including the cushions, ~~are to~~ shall be soundly constructed to withstand the maximum centrifugal force capable of being delivered