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## Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels<sup>1</sup>

This standard is issued under the fixed designation D6751; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 1. Scope\*

1.1 This specification covers four grades of biodiesel (B100) for use as a blend component with middle distillate fuels. These grades are described as follows:

1.1.1 *Grade No. 1-B S15*—A special purpose biodiesel blendstock intended for use in middle distillate fuel applications which can be sensitive to the presence of partially reacted glycerides, including those applications requiring good low temperature operability, and also requiring a fuel blend component with 15 ppm sulfur (maximum).

1.1.2 *Grade No. 1-B S500*—A special purpose biodiesel blendstock intended for use in middle distillate fuel applications which can be sensitive to the presence of partially reacted glycerides, including those applications requiring good low temperature operability, and also requiring a fuel blend component with 500 ppm sulfur (maximum).

1.1.3 *Grade No. 2-B S15*—A general purpose biodiesel blendstock intended for use in middle distillate fuel applications that require a fuel blend component with 15 ppm sulfur (maximum).

1.1.4 *Grade No. 2-B S500*—A general purpose biodiesel blendstock intended for use in middle distillate fuel applications that require a fuel blend component with 500 ppm sulfur (maximum).

1.2 This specification prescribes the required properties of diesel fuels at the time and place of delivery. The specification requirements may be applied at other points in the production and distribution system when provided by agreement between the purchaser and the supplier.

1.3 Nothing in this specification shall preclude observance of federal, state, or local regulations which may be more restrictive.

NOTE 1—The generation and dissipation of static electricity can create problems in the handling of distillate fuel oils with which biodiesel may be blended. For more information on the subject, see Guide [D4865](#).

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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.*

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee [D02](#) on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee [D02.E0](#) on Burner, Diesel and Non-Aviation Gas Turbine Fuels.

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

## 2. Referenced Documents

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

- D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
- D189 Test Method for Conradson Carbon Residue of Petroleum Products
- D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- D524 Test Method for Ramsbottom Carbon Residue of Petroleum Products
- D613 Test Method for Cetane Number of Diesel Fuel Oil
- D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
- D874 Test Method for Sulfated Ash from Lubricating Oils and Additives
- D974 Test Method for Acid and Base Number by Color-Indicator Titration
- D975 Specification for Diesel Fuel
- D976 Test Method for Calculated Cetane Index of Distillate Fuels
- D1160 Test Method for Distillation of Petroleum Products at Reduced Pressure
- D1266 Test Method for Sulfur in Petroleum Products (Lamp Method)
- D1796 Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure)
- D2274 Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method)
- D2500 Test Method for Cloud Point of Petroleum Products and Liquid Fuels
- D2622 Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
- D2709 Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge
- D2880 Specification for Gas Turbine Fuel Oils
- D3120 Test Method for Trace Quantities of Sulfur in Light Liquid Petroleum Hydrocarbons by Oxidative Microcoulometry
- D3242 Test Method for Acidity in Aviation Turbine Fuel
- D3828 Test Methods for Flash Point by Small Scale Closed Cup Tester
- D4057 Practice for Manual Sampling of Petroleum and Petroleum Products
- D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products
- D4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy Dispersive X-ray Fluorescence Spectrometry
- D4530 Test Method for Determination of Carbon Residue (Micro Method)
- D4737 Test Method for Calculated Cetane Index by Four Variable Equation
- D4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems
- D4951 Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry
- D5453 Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence
- D5771 Test Method for Cloud Point of Petroleum Products and Liquid Fuels (Optical Detection Stepped Cooling Method)
- D5772 Test Method for Cloud Point of Petroleum Products and Liquid Fuels (Linear Cooling Rate Method)
- D5773 Test Method for Cloud Point of Petroleum Products and Liquid Fuels (Constant Cooling Rate Method)
- D6217 Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration
- D6450 Test Method for Flash Point by Continuously Closed Cup (CCCFP) Tester
- D6469 Guide for Microbial Contamination in Fuels and Fuel Systems
- D6584 Test Method for Determination of Total Monoglycerides, Total Diglycerides, Total Triglycerides, and Free and Total Glycerin in B-100 Biodiesel Methyl Esters by Gas Chromatography
- D6890 Test Method for Determination of Ignition Delay and Derived Cetane Number (DCN) of Diesel Fuel Oils by Combustion in a Constant Volume Chamber
- D7039 Test Method for Sulfur in Gasoline, Diesel Fuel, Jet Fuel, Kerosine, Biodiesel, Biodiesel Blends, and Gasoline-Ethanol Blends by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry
- D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)
- D7344 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure (Mini Method)
- D7345 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure (Micro Distillation Method)
- D7397 Test Method for Cloud Point of Petroleum Products and Liquid Fuels (Miniaturized Optical Method)
- D7501 Test Method for Determination of Fuel Filter Blocking Potential of Biodiesel Fuel Blendstock (B100) by Cold Soak Filtration Test (CSFT)

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

**D7668** Test Method for Determination of Derived Cetane Number (DCN) of Diesel Fuel Oils—Ignition Delay and Combustion Delay Using a Constant Volume Combustion Chamber Method

**D7689** Test Method for Cloud Point of Petroleum Products and Liquid Fuels (Mini Method)

**D7945** Test Method for Determination of Dynamic Viscosity and Derived Kinematic Viscosity of Liquids by Constant Pressure Viscometer

**D8183** Test Method for Determination of Indicated Cetane Number (ICN) of Diesel Fuel Oils using a Constant Volume Combustion Chamber—Reference Fuels Calibration Method

## 2.2 Government Standard:

**40 CFR Part 79** Registration of Fuels and Fuel Additives Section 211(b) Clean Air Act<sup>3</sup>

## 2.3 Other Documents:

**AOCS Standard Procedure Ck 2-09**<sup>4</sup> Determination of Various Properties of Biodiesel by the QTA System Method<sup>5</sup>

**UOP 389** Trace Metals in Oils by Wet Ashing and ICP-OES<sup>6</sup>

**UOP 391–91** Trace Metals in Petroleum Products or Organics by AAS<sup>6</sup>

**EN 14105** Fat and Oil Derivatives—Fatty Acid Methyl Esters (FAME)—Determination of Free and Total Glycerol and Mono-, Di-, Triglyceride Contents (Reference Method)<sup>7</sup>

**EN 14110** Fat and Oil Derivatives—Fatty Acid Methyl Esters (FAME)—Determination of Methanol Content<sup>7</sup>

**EN 14112** Fat and Oil Derivatives—Fatty Acid Methyl Esters (FAME)—Determination of Oxidation Stability (Accelerated Oxidation Test)<sup>7</sup>

**EN 14538** Fat and Oil Derivatives—Fatty Acid Methyl Esters (FAME)—Determination of Ca, K, Mg and Na Content by Optical Emission Spectral Analysis with Inductively Coupled Plasma (ICP OES)<sup>7</sup>

**EN 15751** Automotive Fuels—Fatty Acid Methyl Ester (FAME) Fuel and Blends with Diesel Fuel—Determination of Oxidation Stability by Accelerated Oxidation Method<sup>7</sup>

## 3. Terminology

### 3.1 Definitions:

**3.1.1 biodiesel, n**—fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100.

#### 3.1.1.1 Discussion—

*biodiesel*, as defined above, is registered with the U.S. EPA as a fuel and a fuel additive under Section 211(b) of the Clean Air Act (40 CFR Part 79). There is, however, other usage of the term *biodiesel* in the marketplace. Due to its EPA registration and the widespread commercial use of the term *biodiesel* in the U.S. marketplace, the term *biodiesel* will be maintained for this specification.

#### 3.1.1.2 Discussion—

Biodiesel is typically produced by a reaction of a vegetable oil or animal fat with an alcohol such as methanol or ethanol in the presence of a catalyst to yield mono-alkyl esters and glycerin, which is removed. The finished biodiesel derives approximately 10 % of its mass from the reacted alcohol. The alcohol used in the reaction may or may not come from renewable resources.

**3.1.2 biodiesel blend (BXX), n**—a homogeneous mixture of hydrocarbon oils and mono-alkyl esters of long chain fatty acids.

#### 3.1.2.1 Discussion—

In the abbreviation BXX, the XX represents the volume percentage of biodiesel fuel in the blend.

#### 3.1.2.2 Discussion—

The mono-alkyl esters of long chain fatty acids (that is, *biodiesel*) used in the mixture shall meet the requirements of Specification D6751.

#### 3.1.2.3 Discussion—

Diesel fuel, fuel oil, and non-aviation gas turbine oil are examples of hydrocarbon oils.

**3.1.3 biodiesel fuel, n**—synonym for *biodiesel*.

**3.1.4 free glycerin, n**—a measure of the amount of glycerin remaining in the fuel.

<sup>3</sup> Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

<sup>4</sup> Available from AOCS Headquarters, 2710 S. Boulder, Urbana, IL 61802–6996. Download Product Code: MC-CK209 from [www.aocs.org](http://www.aocs.org).

<sup>5</sup> QTA is a registered trademark of the Cognis Corporation, 5051 Estecreek Drive, Cincinnati, OH 45232-1446.

<sup>6</sup> Available from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA. Visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org).

<sup>7</sup> Available from the National CEN Members listed on the CEN website ([www.cenorm.be](http://www.cenorm.be)) or from the CEN/TC19 secretariat ([astm@nen.nl](mailto:astm@nen.nl)).

3.1.5 *Grade S15 B100, n*—a grade of biodiesel meeting ASTM Specification D6751 and having a sulfur specification of 15 ppm maximum.

3.1.6 *Grade S500 B100, n*—a grade of biodiesel meeting ASTM Specification D6751 and having a sulfur specification of 500 ppm maximum.

3.1.7 *middle distillate fuel, n*—kerosines and gas oils boiling between approximately 150 °C and 400 °C at normal atmospheric pressure and having a closed-cup flash point above 38 °C.

3.1.8 *monoglyceride, n*—a partially reacted fat or oil molecule with one long chain alkyl ester group on a glycerin backbone.

3.1.9 *total glycerin, n*—the sum of the free glycerin and the glycerin portion of any unreacted or partially reacted oil or fat.

#### 4. Requirements

4.1 The biodiesel specified shall be mono-alkyl esters of long chain fatty acids derived from vegetable oils and animal fats.

4.2 Unless otherwise specified, samples for analysis shall be taken by the procedure described in Practices [D4057](#) or [D4177](#).

4.3 The biodiesel specified shall conform to the detailed requirements shown in [Table 1](#).

NOTE 2—A considerable amount of experience exists in the U.S. with a 20 % blend of biodiesel, primarily produced from soybean oil, with 80 % diesel fuel (B20). Experience with biodiesel produced from animal fat and other oils is similar. Experience with B20 and lower blends in other applications is not as prevalent. Although biodiesel (B100) can be used, blends of over 20 % biodiesel with diesel fuel (B20) should be evaluated on a case by case basis until further experience is available.

NOTE 3—The user should consult the equipment manufacturer or owner's manual regarding the suitability of using biodiesel or biodiesel blends in a particular engine or application.

#### 5. Test Methods

5.1 The requirements enumerated in this specification shall be determined in accordance with the following methods.

5.1.1 *Flash Point*—Test Methods [D93](#), except where other methods are prescribed by law. Test Methods [D3828](#) or [D6450](#) can also be used. The precision and bias of Test Methods [D3828](#) and [D6450](#) with biodiesel is not known and is currently under investigation. Test Methods [D93](#) shall be the referee method.

5.1.2 *Water and Sediment*—Test Method [D2709](#). Test Method [D1796](#) may also be used. Test Method [D2709](#) shall be the referee method. The precision and bias of these test methods with biodiesel is not known and is currently under investigation.

5.1.3 *Viscosity*—Test Methods [D445](#), [D7042](#), or [D7945](#) may be used with the same limits. Bias-corrected results from Test Method [D7042](#) shall be reported as “Predicted [D445](#).” Use bias correction for biodiesel fuel according the Precision and Bias section of Test Method [D7042](#). In case of dispute, Test Method [D445](#) shall be used as the referee test method.

5.1.4 *Monoglycerides*—Test Method [D6584](#), Test Method EN 14105, and AOCs Standard Procedure Ck 2-09 may be used. Test Method [D6584](#) shall be the referee test method.

5.1.5 *Sulfated Ash*—Test Method [D874](#).

5.1.6 *Oxidation Stability*—Test Method EN 15751. Test Method EN 14112 may also be used. See [X1.19.1](#) for further information. Test Method EN 15751 shall be the referee test method.

5.1.7 *Sulfur*—Test Method [D5453](#). Test Method [D7039](#) may also be used. Other test methods may also be suitable for determining up to 0.05 % (500 ppm) sulfur in biodiesel fuels such as Test Methods [D1266](#), [D2622](#), [D3120](#) and [D4294](#) but may provide falsely high results (see [X1.5](#)) although their precision and bias with biodiesel is unknown. Test Method [D5453](#) shall be the referee test method.

**TABLE 1 Detailed Requirements for Biodiesel (B100) Blend Stocks**

Property	Test Method <sup>A</sup>	Grade No. 1-B S15	Grade No. 1-B S500	Grade No. 2-B S15	Grade No. 2-B S500
Sulfur, <sup>B</sup> % mass (ppm), max	D5453	0.0015 (15)	0.05 (500)	0.0015 (15)	0.05 (500)
Cold soak filterability, seconds, max	D7501	200	200	360 <sup>C</sup>	360 <sup>C</sup>
Monoglyceride content, % mass, max	D6584	0.40	0.40	...	...
Requirements for All Grades					
Calcium and Magnesium, combined, ppm (µg/g), max	EN 14538	5	5	5	5
Flash point (closed cup), °C, min	D93	93	93	93	93
Alcohol control					
One of the following shall be met:					
1. Methanol content, mass %, max	EN 14110	0.2	0.2	0.2	0.2
2. Flash point, °C, min	D93	130	130	130	130
Water and sediment, % volume, max	D2709	0.050	0.050	0.050	0.050
Kinematic viscosity, <sup>D</sup> mm <sup>2</sup> /s, 40 °C	D445	1.9-6.0	1.9-6.0	1.9-6.0	1.9-6.0
Sulfated ash, % mass, max	D874	0.020	0.020	0.020	0.020
Copper strip corrosion, max	D130	No. 3	No. 3	No. 3	No. 3
Cetane number, min	D613	47	47	47	47
Cetane number, min	D613	45	45	45	45
Cloud point, <sup>E</sup> °C	D2500	Report	Report	Report	Report
Carbon residue, <sup>F</sup> % mass, max	D4530	0.050	0.050	0.050	0.050
Acid number, mg KOH/g, max	D664	0.50	0.50	0.50	0.50
Free glycerin, % mass, max	D6584	0.020	0.020	0.020	0.020
Total glycerin, % mass, max	D6584	0.240	0.240	0.240	0.240
Phosphorus content, % mass, max	D4951	0.001	0.001	0.001	0.001
Distillation temperature,	D1160	360	360	360	360
Atmospheric equivalent temperature, 90 % recovered, °C, max					
Sodium and Potassium, combined, ppm (µg/g), max	EN 14538	5	5	5	5
Oxidation stability, hours, min	EN 15751	3	3	3	3

<sup>A</sup> The test methods indicated are the approved referee methods. Other acceptable methods are indicated in 5.1.

<sup>B</sup> Other sulfur limits may apply in selected areas in the United States and in other countries.

<sup>C</sup> For additional cold weather considerations, see Appendix X3.

<sup>D</sup> See X1.3.1. The 6.0 mm<sup>2</sup>/s upper viscosity limit is higher than petroleum based diesel fuel and should be taken into consideration when blending.

<sup>E</sup> The cloud point of biodiesel is generally higher than petroleum based diesel fuel and should be taken into consideration when blending.

<sup>F</sup> Carbon residue shall be run on the 100 % sample (see 5.1.12).

5.1.8 *Corrosion*—Test Method **D130**, 3 h test at 50 °C.

5.1.9 *Cetane Number*—Test Method **D613**. Test Method **D6890**, **D7668** (see **Note 4**), or **D8183** (**Note 5**) may also be used. In case of dispute, Test Method **D613** shall be the referee method.

NOTE 4—Precision from Test Method **D7668** were obtained from results produced by laboratories using externally obtained pre-blended calibration reference material.

NOTE 5—Precision from Test Method **D8183** were obtained from results produced by laboratories using pre-blended calibration reference materials from a single source.

5.1.10 *Cloud Point*—Test Method **D2500**. Test Method **D5771**, **D5772**, **D5773**, **D7397**, **D7689**, or AOCS Standard Procedure Ck 2-09 may also be used. Test Method **D2500** shall be the referee test method.

5.1.11 *Acid Number*—Test Method **D664**. Test Methods **D3242** or **D974** may also be used. Test Method **D664** shall be the referee test method.

5.1.12 *Carbon Residue*—Test Method **D4530**. A 100 % sample shall replace the 10 % residual, with percent residue in the original sample reported using the 10 % residual calculation (see **X1.9.1**). Test Methods **D189** or **D524** may also be used. Test Method **D4530** shall be the referee method.

5.1.13 *Total Glycerin*—Test Method **D6584**. AOCS Standard Procedure Ck 2-09 may also be used. Test Method **D6584** is the referee method.

5.1.14 *Free Glycerin*—Test Method **D6584**. AOCS Standard Procedure Ck 2-09 may also be used. Test Method **D6584** is the referee method.

5.1.15 *Phosphorus Content*—Test Method **D4951**.

5.1.16 *Distillation Temperature*—Test Method(s) **D1160** (reduced pressure method), or **D7344**, or **D7345** may be used. When using Test Method **D7344**, correct for observed bias by adding 3 °C to the temperature result before comparing the result to the **Table 1** requirement and report the Test Method **D7344** value as “bias-corrected.” Test Method **D1160** shall be the referee test method.

5.1.17 *Calcium and Magnesium, combined*—Test Method EN 14538. Test Method UOP 389 may also be used. Test Method EN 14538 shall be the referee test method.

5.1.18 *Sodium and Potassium, combined*—Test Method EN 14538. Test Method UOP 391 may also be used. Test Method EN 14538 shall be the referee test method.

5.1.19 *Cold Soak Filterability*—Test Method **D7501**. B100 intended for blending into diesel fuels that is expected to give satisfactory vehicle performance at fuel temperatures at or below –12 °C shall comply with a cold soak filtration limit of 200 s maximum.

5.1.20 *Methanol Content*—Test Method EN 14110. AOCS Standard Procedure Ck 2-09 may also be used. Test Method EN 14110 shall be the referee test method.

## 6. Workmanship

6.1 The biodiesel fuel shall be visually free of undissolved water, sediment, and suspended matter.

## 7. Keywords

7.1 alternative fuel; biodiesel fuel; diesel fuel oil; fuel oil; renewable resource

## APPENDIXES

(Nonmandatory Information)

### X1. SIGNIFICANCE OF PROPERTIES SPECIFIED FOR BIODIESEL FUEL

#### X1.1 Introduction

X1.1.1 The properties of commercial biodiesel fuel depends upon the refining practices employed and the nature of the renewable lipids from which it is produced. Biodiesel, for example, can be produced from a variety of vegetable oils or animal fats which produce similar volatility characteristics and combustion emissions with varying cold flow properties.

X1.1.2 The significance of the properties in this appendix are based primarily on the commercial use of biodiesel in on-road and off-road diesel engine applications. Some of the properties may take on other significance if biodiesel is used as a fuel or blending component in other applications. See the respective finished product specifications for additional information on significance of properties of those applications.

#### X1.2 Flash Point

X1.2.1 The flash point, as specified, is not directly related to engine performance. It is, however, of importance in connection with legal requirements and safety precautions involved in fuel handling and storage that are normally specified to meet insurance and fire regulations.

X1.2.2 The flash point for biodiesel has been set at 93 °C (200 °F) minimum, so biodiesel falls under the non-hazardous category under National Fire Protection Association codes.

#### X1.3 Viscosity

X1.3.1 For some engines it may be advantageous to specify a minimum viscosity because of power loss due to injection pump and injector leakage. Maximum allowable viscosity, on the other hand, is limited by considerations involved in engine design and size, and the characteristics of the injection system. The upper limit for the viscosity of biodiesel (6.0 mm<sup>2</sup>/s at 40 °C) is higher than the maximum allowable viscosity in Specification **D975** Grade 2-D and 2-D low sulfur (4.1 mm<sup>2</sup>/s at 40 °C). Blending biodiesel with diesel fuel close to its upper limit could result in a biodiesel blend with viscosity above the upper limits contained in Specification **D975**.

#### X1.4 Sulfated Ash

X1.4.1 Ash-forming materials may be present in biodiesel in three forms: (1) abrasive solids, (2) soluble metallic soaps, and (3) unremoved catalysts. Abrasive solids and unremoved catalysts can contribute to injector, fuel pump, piston and ring wear, and also to engine deposits. Soluble metallic soaps have little effect on wear but may contribute to filter plugging and engine deposits.