



Designation: ~~D7467–20a~~ D7467 – 23

Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20)¹

This standard is issued under the fixed designation D7467; 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 specification covers fuel blend grades of ~~6 volume percent to 20 volume percent (%)~~ 6 % to 20 % by volume biodiesel with the remainder being a light middle or middle distillate diesel fuel, collectively designated as B6 to B20. These grades are suitable for various types of diesel engines.

1.1.1 The biodiesel component of the blend shall conform to the requirements of Specification **D6751**. For grade B6-B20 S15 the biodiesel component shall be grade **D6751** S15 LM, except as allowed under **6.1.1.1** for S15 fuels used in diesel engines without Selective Catalytic Reduction (SCR) or Diesel Particulate Filter (DPF) aftertreatment technology. The remainder of the fuel shall be a light middle or middle distillate grade diesel fuel conforming to Specification **D975** grades No. 1-D and No. 2-D of any sulfur level specified with the following exceptions. The light middle or middle distillate grade diesel fuel whose sulfur level, aromatic level, cetane, or lubricity falls outside of Specification **D975** may be blended with biodiesel meeting Specification **D6751**, provided the finished mixtures meets this specification.

1.1.2 The fuel sulfur grades are described as follows:

1.1.2.1 *Grade B6 to B20 S15*—A fuel with a maximum of 15 ppm sulfur.

1.1.2.2 *Grade B6 to B20 S500*—A fuel with a maximum of 500 ppm sulfur.

1.1.2.3 *Grade B6 to B20 S5000*—A fuel with a maximum of 5000 ppm sulfur.

1.2 This specification prescribes the required properties of B6 to B20 biodiesel blends 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.

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

NOTE 1—The generation and dissipation of static electricity can create problems in the handling of distillate diesel fuel oils. For more information on this subject, see Guide **D4865**.

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

1.4 *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.*

¹ 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, Diesel and Non-Aviation Gas Turbine, and Marine 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:²

- D56 Test Method for Flash Point by Tag Closed Cup Tester
- D86 Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure
- D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- D129 Test Method for Sulfur in Petroleum Products (General High Pressure Decomposition Device Method)
- D130 Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
- D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- D482 Test Method for Ash from Petroleum Products
- 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
- D975 Specification for Diesel Fuel
- D976 Test Method for Calculated Cetane Index of Distillate Fuels
- D1266 Test Method for Sulfur in Petroleum Products (Lamp Method)
- D1319 Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption
- D1552 Test Method for Sulfur in Petroleum Products by High Temperature Combustion and Infrared (IR) Detection or Thermal Conductivity Detection (TCD)
- 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
- D2624 Test Methods for Electrical Conductivity of Aviation and Distillate Fuels
- 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
- D3828 Test Methods for Flash Point by Small Scale Closed Cup Tester
- D4057 Practice for Manual Sampling of Petroleum and Petroleum Products
- D4294 Test Method for Sulfur in Petroleum and Petroleum Products by Energy Dispersive X-ray Fluorescence Spectrometry
- D4308 Test Method for Electrical Conductivity of Liquid Hydrocarbons by Precision Meter
- D4539 Test Method for Filterability of Diesel Fuels by Low-Temperature Flow Test (LTFT)
- D4737 Test Method for Calculated Cetane Index by Four Variable Equation
- D4865 Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems
- 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)
- D6079 Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)
- D6217 Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration
- D6304 Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
- D6371 Test Method for Cold Filter Plugging Point of Diesel and Heating Fuels
- D6468 Test Method for High Temperature Stability of Middle Distillate Fuels
- D6469 Guide for Microbial Contamination in Fuels and Fuel Systems
- D6751 Specification for Biodiesel Fuel Blendstock (B100) for Middle Distillate Fuels
- D6890 Test Method for Determination of Ignition Delay and Derived Cetane Number (DCN) of Diesel Fuel Oils by Combustion in a Constant Volume Chamber
- D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)
- D7094 Test Method for Flash Point by Modified Continuously Closed Cup (MCCCFP) Tester
- D7220 Test Method for Sulfur in Automotive, Heating, and Jet Fuels by Monochromatic Energy Dispersive X-ray Fluorescence Spectrometry
- 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)

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.

- D7371 Test Method for Determination of Biodiesel (Fatty Acid Methyl Esters) Content in Diesel Fuel Oil Using Mid Infrared Spectroscopy (FTIR-ATR-PLS Method)
- D7397 Test Method for Cloud Point of Petroleum Products and Liquid Fuels (Miniaturized Optical Method)
- D7619 Test Method for Sizing and Counting Particles in Light and Middle Distillate Fuels, by Automatic Particle Counter
- 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)
- D7861 Test Method for Determination of Fatty Acid Methyl Esters (FAME) in Diesel Fuel by Linear Variable Filter (LVF) Array Based Mid-Infrared Spectroscopy
- 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
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E1064 Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration

2.2 Other Standards:

- 26 CFR Part 48 Manufacturers and Retailers Excise Taxes³
- 40 CFR Part 80 Regulation of Fuels and Fuel Additives³
- EN 14078 Liquid Petroleum Products—Determination of Fatty Acid Methyl Ester (FAME) Content in Middle Distillates—Infrared Spectrometry Method⁴
- EN 14112 Fat and Oil Derivatives—Fatty Acid Methyl Esters (FAME)—Determination of Oxidation Stability (Accelerated Oxidation Test)⁴
- EN 15751 Automotive Fuels—Fatty Acid Methyl Ester (FAME) Fuel and Blends with Diesel Fuel—Determination of Oxidation Stability by Accelerated Oxidation Method⁴
- ISO 4406 Hydraulic Fluid Power—Fluids—Method for Coding the Level of Contamination by Solid Particles⁵
- ISO 16889 Hydraulic Fluid Power—Filters—Multi-pass Method for Evaluating Filtration Performance of a Filter Element⁵

3. Terminology

3.1 Definitions:

3.1.1 *B6 to B20, n*—fuel blend consisting of 6 volume percent to 20 volume percent 6 % to 20 % by volume biodiesel conforming to the requirements of Specification D6751 with the remainder being a light middle or middle distillate grade diesel fuel and meeting the requirements of this specification.

3.1.1.1 Discussion—

The abbreviation BXX represents a specific blend concentration in the range B6 to B20, where XX is the percent volume of biodiesel in the fuel blend.

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

3.1.3 *S(numerical specification maximum), n*—a part of the grade name that states the maximum sulfur content, in ppm by mass (mg/kg), allowed by this specification.

3.1.3.1 Discussion—

mg/kg is equivalent to $\mu\text{g/g}$, 1×10^{-4} % by mass, and mass fraction 0.000001.

3.1.3.2 Discussion—

Most, but not all, test methods to determine sulfur content mentioned in this specification produce results in units of mg/kg. Consult the test method in use to determine units for a particular result.

4. Test Methods

4.1 The requirements enumerated in this specification shall be determined in accordance with the following methods:

4.1.1 *Acid Number*—Test Method D664.

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

⁴ Available from the National CEN members listed on the CEN website (www.cenorm.be) or from the CEN/TC 19 Secretariat (astm@nen.nl).

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

4.1.2 **Flash Point**—Test Method **D93**, except where other methods are prescribed by law. For all grades, Test Method **D3828** and Test Method **D7094** may be used as an alternate with the same limits. Test Method **D56** may be used as an alternate with the same limits, provided the flash point is below 93 °C. This test method will give slightly lower values. In cases of dispute, Test Method **D93** shall be used as the referee method.

4.1.3 **Cloud Point**—Test Method **D2500**. For all B6 to B20 grades in **Table 1**, Test Method **D7397** and the automatic Test Methods **D5771**, **D5772**, **D5773**, or **D7689** may be used as alternates with the same limits. In case of dispute, Test Method **D2500** shall be the referee test method.

TABLE 1 Detailed Requirements for B6 to B20 Biodiesel Blends

Property	Test Method	Grade		
		B6 to B20 S15	B6 to B20 S500 ^A	B6 to B20 S5000 ^B
Acid Number, mg KOH/g, max	D664	0.3	0.3	0.3
Viscosity, mm ² /s at 40 °C	D445	1.9-4.1 ^C	1.9-4.1 ^C	1.9- 4.1 ^C
Flash Point, °C, min	D93	52 ^D	52 ^D	52 ^D
Cloud Point, °C, max or LTFT/CFPP, °C, max	D2500, D4539, D6371	<i>E</i>	<i>E</i>	<i>E</i>
Sulfur Content, (µg/g) ^F	D5453	15
mass percent, max	D2622	...	0.05	...
mass percent, max	D129	0.50
Distillation Temperature, °C, 90 % vol recovered, max	D86	343	343	343
Ramsbottom Carbon Residue on 10 % bottoms, mass %, max	D524	0.35	0.35	0.35
Cetane Number, min	D613^G	40 ^H	40 ^H	40 ^H
One of the following must be met:	D976-80^I	40	40	40
(1) Cetane index, min.				
(2) Aromaticity, volume percent, max	D1319^J -03^I	35	35	...
Ash Content, mass percent, max	D482	0.01	0.01	0.01
Water and Sediment, volume percent, max	D2709	0.05	0.05	0.05
Copper Corrosion, 3 h at 50 °C, max	D130	No. 3	No. 3	No. 3
Biodiesel Content, % (V/V)	D7371	6. - 20.	6. - 20.	6. - 20.
Oxidation Stability, hours, min	EN 15751	6	6	6
Lubricity, HFRR at 60 °C, micron (µm), max	D6079	520 ^K	520 ^K	520 ^K
Conductivity (pS/m) or Conductivity Units (C.U.), min	D2624/D4308	25 ^L	25 ^L	25 ^L

^A Under United States of America regulations, if Grades B6-20 S500 are sold for tax exempt purposes then, at, or beyond terminal storage tanks, they are required by 26 CFR Part 48 to contain the dye Solvent Red 164 at a concentration spectrally equivalent to 3.9 lb of the solid dye standard Solvent Red 26 per thousand barrels of diesel fuel or kerosine, or the tax must be collected.

^B Under United States of America regulations, Grades B6-20 S5000 are required by 40 CFR part 80 to contain a sufficient amount of the dye Solvent Red 164 so its presence is visually apparent. At or beyond terminal storage tanks, they are required by 26 CFR Part 48 to contain the dye Solvent Red 164 at a concentration spectrally equivalent to 3.9 lb of the solid dye standard Solvent Red 26 per thousand barrels of diesel fuel or kerosine.

^C If Grade No. 1-D or blends of Grade No. 1-D and Grade No. 2-D diesel fuel are used, the minimum viscosity shall be 1.3 mm²/s.

^D If Grade No. 1-D or blends of Grade No. 1-D and Grade No. 2-D diesel fuel are used, or a cloud point of less than -12 °C is specified, the minimum flash point shall be 38 °C.

^E It is unrealistic to specify low temperature properties that will ensure satisfactory operation at all ambient conditions. In general, cloud point Low Temperature Flow Test, and Cold Filter Plugging Point Test may be useful to estimate vehicle low temperature operability limits but their use with B6 to B20 has not been validated. However, satisfactory operation below the cloud point may be achieved depending on equipment design, operating conditions, and the use of flow-improver additives as described in **X3.1.2**. Appropriate low temperature operability properties should be agreed upon between the fuel supplier and purchaser for the intended use and expected ambient temperatures. Test Methods **D4539** and **D6371** may be especially useful to estimate vehicle low temperature operability limits when flow improvers are used but their use with B6 to B20 from a full range of biodiesel feedstock sources has not been validated. Due to fuel delivery system, engine design, and test method differences, low temperature operability tests may not provide the same degree of protection in various vehicle operating classes. Tenth percentile minimum air temperatures for U.S. locations are provided in **Appendix X3** as a means of estimating expected regional temperatures. The tenth percentile minimum air temperatures may be used to estimate expected regional target temperatures for use with Test Methods **D2500**, **D4539**, and **D6371**. Refer to **X3.1.3** for further general guidance on test application.

^F Other sulfur limits can apply in selected areas in the United States and in other countries.

^G Calculated cetane index approximation, Test Method **D4737**, is not applicable to biodiesel blends.

^H Low ambient temperatures, as well as engine operation at high altitudes, may require the use of fuels with higher cetane ratings. If the diesel fuel is qualified under Table 1 of Specification **D975** for cetane, it is not necessary to measure the cetane number of the blend. This is because the cetane number of the individual blend components will be at least 40, so the resulting blend will also be at least 40 cetane number.

^I These test methods are specified in 40 CFR Part 80.

^J See **4.1.12**.

^K If the diesel fuel is qualified under Table 1 of Specification **D975** for lubricity, it is not necessary to measure the lubricity of the blend. This is because the lubricity of the individual blend components will be less than 520 µm so the resulting blend will also be less than 520 µm.

^L The electrical conductivity of the fuel oil is measured at the time and temperature of the fuel at delivery. The 25 pS/m minimum conductivity requirement applies at all instances of high velocity transfer (7 m/s) but sometimes lower velocities, see **7.1** for detailed requirements) into mobile transport (for example, tanker trucks, rail cars, and barges).

4.1.4 *Cold Filter Plugging Point (CFPP)*—Test Method **D6371**.

4.1.5 *Low Temperature Flow Test (LTFT)*—Test Method **D4539**.

4.1.6 *Water and Sediment*—Test Method **D2709**. See **Appendix X4** for additional guidance on water and sediment in biodiesel blends.

4.1.7 *Carbon Residue*—Test Method **D524**.

4.1.8 *Ash*—Test Method **D482**.

4.1.9 *Distillation*—Test Method **D86**, **D7344**, or **D7345**. For all grades, Test Method **D7344** can be used as an alternative. Results from Test Method **D7344** shall be reported as “Predicted D86” results by application of the corrections described in Test Method **D7344** to improve agreement with D86 values. Results from Test Method **D7345** shall be reported as “Predicted D86” results by application of the corrections described in Test Method **D7345** to improve agreement with D86 values. In case of dispute, Test Method **D86** shall be used as the referee test method.

4.1.10 *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 to the Precision and Bias section of **D7042**. In case of dispute, Test Method **D445** shall be used as the referee test method.

4.1.11 *Sulfur*—**Table 2** shows the referee test methods and alternate test methods for sulfur, the range over which each test method applies and the corresponding fuel grades.

4.1.12 *Aromaticity*—Test Method **D1319**. This test method provides an indication of the aromatic content of fuels. For fuels with a maximum final boiling point of 315 °C, this test method is a measurement of the aromatic content of the fuel. Grade S5000 does not have an aromatics content. The supplier of the fluorescent indicator dyed gel used in Test Method **D1319** (and IP 156) is no longer able to supply the dye needed for the method to work with diesel fuel. Lot numbers 3000000975 and above will not provide correct aromatics values.

4.1.13 *Cetane Index*—Test Method **D976**.

4.1.14 *Lubricity*—Test Method **D6079**.

4.1.15 *Copper Corrosion*—Test Method **D130**, 3 h test at 50 °C minimum.

4.1.16 *Cetane Number*—Test Method **D613**. Test Method **D6890**, **D7668** (see **Note 2**), or **D8183** (see **Note 3**) may also be used. In cases of dispute, Test Method **D613** shall be the referee test method.

TABLE 2 Sulfur Test Methods

Sulfur Test Method	Range	Grades	Units Used to Report Results ^A
D129 (referee)	>0.1 % mass	S5000	mass percent
D1266	0.0005 % to 0.4 % mass	S500	mass percent
D1552	5 mg/kg to 4000 mg/kg (wt ppm)	S5000	mass percent
D2622	>0.06 % mass	all grades	mass percent
(referee for S500 grades)	0.0003 % to 5.3 % mass		
D3120	3 mg/kg to 53 000 mg/kg (wt ppm)	S15, S500 (S500 grades must be diluted before testing)	ppm (µg/g)
D4294	3.0 mg/kg to 100 mg/kg (wt ppm)	S5000	mass percent
D5453	0.0150 % to 5.00 % mass	all grades	ppm (µg/g)
(referee for S15 grades)	150 mg/kg to 50 000 mg/kg (wt ppm)		
D7220	0.0001 % to 0.8 % mass	all grades	ppm (µg/g)
	1.0 mg/kg to 8000 mg/kg (wt ppm)	S15, S500	mass ppm (µg/g)
	3.0 mg/kg to 942 mg/kg (mass ppm)		

^A Results reported in mg/kg and in ppm (µg/g) are numerically the same. The units used in **Table 1** for the sulfur requirements are the units in which results for the referee test are reported.

NOTE 2—Precision from Test Method **D7668** were obtained from results produced by laboratories using externally obtained pre-blended calibration reference material.

NOTE 3—Precision from Test Method **D8183** were obtained from results produced by laboratories using pre-blended calibration reference materials from a single source.

4.1.17 *Oxidation Stability*—Test Method EN 15751. Test Method EN 14112 may also be used but has been shown to provide falsely low readings in some cases. See **X1.16.2** for further information. In case of dispute, Test Method EN 15751 shall be the referee test method.

4.1.18 *Biodiesel Content*—Test Method **D7371**. Test Method EN 14078 or Test Method **D7861** may also be used. In cases of dispute, Test Method **D7371** shall be the referee test method. See Practice **E29** for guidance on significant digits.

4.1.19 *Conductivity*—Both conductivity test methods, Test Methods **D2624** and **D4308**, are allowed for all B6 to B20 grades. For conductivities below 1 pS/m, Test Method **D4308** is preferred.

5. Workmanship

5.1 The biodiesel blend (B6 to B20) shall be visually free of undissolved water, sediment, and suspended matter.

5.2 The biodiesel blend (B6 to B20) shall also be free of any adulterant or contaminant that may render the fuel unacceptable for its commonly used applications.

6. Requirements

6.1 The biodiesel blend (B6 to B20) specified shall conform to the detailed requirements shown in **Table 1**.

6.1.1 For grade B6-B20 S15 the biodiesel component shall be grade **D6751** S15 LM, except as provided in **6.1.1.1**.

6.1.1.1 Grade B6-B20 S15 fuels used in diesel engines that do not have Selective Catalytic Reduction (SCR) or Diesel Particulate Filter (DPF) aftertreatment technology may use biodiesel meeting grades ASTM **D6751** S15 or S15 LM.

7. Precautionary Notes on Conductivity

7.1 Accumulation of static charge occurs when a hydrocarbon liquid flows with respect to another surface. The electrical conductivity requirement of 25 pS/m minimum at temperature of delivery shall apply when the transfer conditions in **Table 3** exist for the delivery into a mobile transport container (for example, tanker trucks, railcars, and barges).

8. Keywords

8.1 biodiesel; biodiesel blend; diesel; fuel oil; petroleum and petroleum products

TABLE 3 Transfer Conditions

Maximum Pipe Diameter (for a distance of 30 s upstream of delivery nozzle)	When Filling Tank Truck Compartments	When Filling Undivided Rail Car Compartments	When Filling Marine Vessels
0.1023 m	Fuel velocity \geq 4.9 m/s	Fuel velocity \geq 7.0 m/s	Fuel velocity \geq 7.0 m/s
0.1541 m	Fuel velocity \geq 3.24 m/s	Fuel velocity \geq 5.20 m/s	Fuel velocity \geq 7.0 m/s
0.2027 m	Fuel velocity \geq 2.47 m/s	Fuel velocity \geq 3.90 m/s	Fuel velocity \geq 7.0 m/s
0.2545 m	Fuel velocity \geq 1.96 m/s	Fuel velocity \geq 3.14 m/s	Fuel velocity \geq 7.0 m/s

APPENDIXES

(Nonmandatory Information)

X1. SIGNIFICANCE OF ASTM SPECIFICATION FOR B6 to B20 BIODIESEL BLENDS

X1.1 Introduction

X1.1.1 The properties of commercial B6 to B20 blends depend on the refining practices employed and the nature of the distillate fuel oils and biodiesel from which they are produced. Distillate fuel oils, for example, may be produced within the boiling range of 150 °C and 400 °C having many possible combinations of various properties, such as volatility, ignition quality, viscosity, and other characteristics. Biodiesel, for example, can be produced from a variety of animal fats or vegetable oils that produce similar volatility characteristics and combustion emissions with varying cold flow properties.

X1.2 Cetane Number

X1.2.1 Cetane number is a measure of the ignition quality of the fuel and influences combustion roughness. The cetane number requirements depend on engine design, size, nature of speed and load variations, and on starting and atmospheric conditions. Increase in cetane number over values actually required does not materially improve engine performance. Accordingly, the cetane number specified should be as low as possible to ensure maximum fuel availability.

X1.3 Distillation

[ASTM D7467-23](https://standards.iteh.ai/catalog/standards/sist/3a51ced6-ba45-4fb0-8126-8d67f5c2cbd2/astm-d7467-23)

<https://standards.iteh.ai/catalog/standards/sist/3a51ced6-ba45-4fb0-8126-8d67f5c2cbd2/astm-d7467-23>

X1.3.1 The fuel volatility requirements depend on engine design, size, nature of speed and load variations, and starting and atmospheric conditions. For engines in services involving rapidly fluctuating loads and speeds, as in bus and truck operation, the more volatile fuels may provide best performance, particularly with respect to smoke and odor. The biodiesel portion of the B6 to B20 may also provide smoke and odor improvements. However, best fuel economy is generally obtained from the heavier types of fuels because of their higher heat content.

X1.4 Viscosity

X1.4.1 For some engines it is advantageous to specify a minimum viscosity because of power loss due to injection pump and injector leakage. Maximum viscosity, on the other hand, is limited by considerations involved in engine design and size, and the characteristics of the injection system.

X1.5 Carbon Residue

X1.5.1 Carbon residue gives a measure of the carbon depositing tendencies of a fuel oil when heated in a bulb under prescribed conditions. While not directly correlating with engine deposits, this property is considered an approximation.

X1.6 Sulfur

X1.6.1 The effect of sulfur content on engine wear and deposits appears to vary considerably in importance and depends largely on operating conditions. Fuel sulfur can affect emission control systems performance. To ensure maximum availability of fuels, the permissible sulfur content should be specified as high as is practicable, consistent with maintenance considerations and legal limits.

X1.7 Flash Point

X1.7.1 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, and it is normally specified to meet insurance and fire regulations.

X1.8 Cloud Point

X1.8.1 Cloud point is of importance in that it defines the temperature at which a cloud or haze of wax crystals appears in the oil under prescribed test conditions that generally relates to the temperature at which wax crystals begin to precipitate from the oil in use.

X1.9 Ash

[ASTM D7467-23](https://standards.iteh.ai/catalog/standards/sist/3a51ced6-ba45-4fb0-8126-8d67f5c2cbd2/astm-d7467-23)

<https://standards.iteh.ai/catalog/standards/sist/3a51ced6-ba45-4fb0-8126-8d67f5c2cbd2/astm-d7467-23>

X1.9.1 Ash-forming materials may be present in fuel oil in three forms: (1) abrasive solids, (2) soluble metallic soaps, and (3) unremoved biodiesel catalysts. Abrasive solids and unremoved biodiesel catalysts 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 engine deposits and filter clogging.

X1.10 Copper Strip Corrosion

X1.10.1 This test serves as a measure of possible difficulties with copper and brass or bronze parts of the fuel system.

X1.11 Aromaticity

X1.11.1 This test is used as an indication of the aromatics content of diesel fuel. Aromatics content is specified to prevent an increase in the average aromatics content in diesel fuels. Increases in aromatics content of fuels over current levels may have a negative impact on emissions. Use of Test Method **D1319-03** or cetane index, Test Method **D976-80**, is required in the United States of America by 40 CFR Part 80. The precision and bias of Test Method **D1319-03** with biodiesel blends is not known and is currently under investigation.

X1.12 Cetane Index

X1.12.1 Cetane index is specified as a limitation on the amount of high aromatic components in S15 and S500 Grades. Use of Test Method **D1319-03** or cetane index, Test Method **D976-80**, is required in the United States of America by 40 CFR Part 80. The precision and bias of Test Method **D976-80** with biodiesel blends is not known.

X1.13 Total and Free Glycerin

X1.13.1 High levels of total or free glycerin can cause injector deposits and may adversely affect cold weather operation and filter plugging and result in a buildup of material in the bottom of storage and fueling systems. The total and free glycerin levels are controlled by Specification **D6751** to 0.24 % mass maximum and 0.02 % mass maximum, respectively. Diesel fuel contains no total or free glycerin, so the level of total and free glycerin in a biodiesel blend is solely derived from the biodiesel contribution and is extremely low and in direct proportion to the level of biodiesel added and its total and free glycerin values. In finished blends, the ability to measure total and free glycerin is compromised by interference with naturally occurring petroleum diesel fuel components and the extremely low values. No ASTM test methods for measuring total and free glycerin in blends currently exist, so no specification for the finished B6 to B20 blend is included. If test methods become available, the level of total and free glycerin should not exceed the maximum contribution derived from biodiesel based on the blend content and the maximum level allowed in Specification **D6751**.

X1.14 Calcium and Magnesium, Sodium and Potassium, and Phosphorus Content

X1.14.1 Calcium and magnesium combined and sodium and potassium combined are controlled to 5 ppm maximum in Specification **D6751**. Phosphorus is controlled to 10 ppm maximum in Specification **D6751**. The presence of high levels of these elements could adversely affect exhaust catalysts and after-treatment systems. The concentration of these materials due to biodiesel in a B6 to B20 blends should be less than 1 or 2 ppm, making accurate measurement difficult. There are also no controls for these materials in Specification **D975** at present and no available database for the potential contribution of these materials from petroleum based diesel fuel. Based on this, a specification for finished blends for these compounds has not been established. If measured, the level of these materials should not exceed the maximum contribution derived from biodiesel based on the blend content and the maximum level allowed in Specification **D6751** and the contribution of the petroleum based diesel fuel.

X1.15 Other

X1.15.1 Microbial Contamination:

X1.15.1.1 Uncontrolled microbial contamination in fuel systems can cause or contribute to a variety of problems, including increased corrosivity and decreased stability, filterability, and caloric value. Microbial processes in fuel systems can also cause or contribute to system damage.

X1.15.1.2 Because the microbes contributing to the aforementioned problems are not necessarily present in the fuel itself, no microbial quality criterion for fuels is recommended. However, it is important that personnel responsible for fuel quality understand how uncontrolled microbial contamination can affect fuel quality.

X1.15.1.3 Guide **D6469** provides personnel with limited microbiological background an understanding of the symptoms,

occurrences, and consequences of microbial contamination. Guide **D6469** also suggests means for detecting and controlling microbial contamination in fuels and fuel systems. Good housekeeping, especially keeping fuel dry, is critical.

X1.16 Oxidation Stability

X1.16.1 If the biodiesel is qualified under Table 1 of Specification **D6751** for oxidation stability, it may not be necessary to measure the oxidation stability of the blend. Existing data⁶ indicates the oxidation stability of B6 to B20 should be over 6 h if the oxidation stability of the biodiesel is 3 h or higher at the time of blending.

X1.16.2 Special precautions may be necessary to eliminate falsely low readings using EN 14112 with biodiesel blends. The petroleum portion of the blend may affect tubing between the reaction vessel and the measuring vessel and the plastic seal on the top of the reaction vessel or condense in various parts of the test setup. Some of these parts may need to be replaced frequently, and all components should be thoroughly cleaned to prevent falsely low readings. Improvements to these parts and changes in the test method have been incorporated into a revised method, EN 15751, which is the referee method. It is recommended that EN 15751 be utilized for measurement of biodiesel blend oxidation stability, because EN 14112 may be withdrawn in the future as an option for testing biodiesel and biodiesel blends.

X1.17 Acid Number

X1.17.1 The acid number is used to determine the level of free fatty acids or processing acids that may be present in the biodiesel or diesel fuel oil when produced, or those which form upon aging. Biodiesel blends with a high acid number have been shown to increase fueling system deposits and may increase the likelihood for corrosion.

X2. STORAGE AND THERMAL STABILITY OF B6 TO B20 BLENDS

[ASTM D7467-23](http://standards.iteh.ai/catalog/standards/sist/3a51ced6-ba45-4fb0-8126-8d67f5c2cbd2/astm-d7467-23)

X2.1 Scope

X2.1.1 This appendix provides guidance for consumers of B6 to B20 who may wish to store quantities of fuels for extended periods or use the fuel in severe service or high temperature applications. Fuels containing residual components are excluded. Consistently successful long-term fuel storage or use in severe applications requires attention to fuel selection, storage conditions, handling and monitoring of properties during storage and prior to use.

X2.1.2 Normally produced fuels have adequate stability properties to withstand normal storage and use without the formation of troublesome amounts of insoluble degradation products although data suggests some B6 to B20 blends may degrade faster than petrodiesel. Fuels that are to be stored for prolonged periods or used in severe applications should be selected to avoid formation of sediments or gums, high acid numbers, or high viscosity which can overload filters or plug injectors. Selection of these fuels should result from supplier-user discussions.

X2.1.3 These suggested practices are general in nature and should not be considered substitutes for any requirements imposed by the warranty of the distillate fuel equipment manufacturer or by federal, state, or local government regulations. Although they cannot replace a knowledge of local conditions or good engineering and scientific judgment, these suggested practices do provide guidance in developing an individual fuel management system for the B6 to B20 fuel user. They include suggestions in the

⁶ McCormick, R. L., and Westbrook, S. R., "Empirical Study of the Stability of Biodiesel and Biodiesel Blends, Milestone Report," NREL/TP-540-41619, National Renewable Energy Laboratory, Golden, Colorado, May 2007. <http://www.nrel.gov/docs/fy07osti/41619.pdf>.