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National Standard of Canada

Diesel fuel containing biodiesel (B6–B20)

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Diesel fuel containing biodiesel (B6-B20)

1 Scope

This standard applies to Type B, B*xx* diesel fuel containing from 6% to 20% by volume of biodiesel. Fuel to this standard is intended for use in high-speed diesel powered equipment for on-road and off-road applications and in select equipment powered by medium-speed diesel engines.

Users of fuel meeting this standard are advised to refer to the owner's manual of their vehicle, engine or equipment, or to consult with their equipment's manufacturer regarding the suitability of the specific fuel blend prior to its use[1, 2].

Fuel to this standard is intended for use in diesel engine-powered equipment that is approved by manufacturers, or suitably converted, to be compatible with fuel blends conforming to this standard. The blends of biodiesel covered by this standard are more appropriate for fleets and users who understand and can manage the potential risks.

Fuel meeting this standard may be used for underground mining applications that were formerly covered by CAN/CGSB-3.16 (See footnote a and Annex C for notes related to the flash point).

Many types of vehicles, engines and equipment (either new or older) are not designed for fuel blends covered by this standard (B6-B20), and use of such biodiesel blends could result in unsatisfactory operation, engine or equipment damage.

Experience with B6 to B20 biodiesel fuel blends under Canadian conditions is limited. This fuel is intended for use when ambient temperatures and fuel storage conditions permit.

Fuels meeting this standard may not be available in areas that experience low temperatures during fall, winter and spring, due to the difficulty of making these biodiesel blends meet the specified low temperature operability requirements.

See Annex B for regulations that apply to diesel fuels.

The testing and evaluation of a product against this standard may require the use of materials and/or equipment that could be hazardous. This document does not purport to address all the safety aspects associated with its use. Anyone using this standard has the responsibility to consult the appropriate authorities and to establish appropriate health and safety practices in conjunction with any applicable regulatory requirements prior to its use.

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this National Standard of Canada. The referenced documents may be obtained from the sources noted below.

NOTE The addresses provided below were valid at the date of publication of this standard.

An undated reference is to the latest edition or revision of the reference or document in question, unless otherwise specified by the authority applying this National Standard of Canada. A dated reference is to the specified revision or edition of the reference or document in question.

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[1] Users of this standard can obtain additional information on the use of Fatty Acid Methyl Esters (FAME) and the use of biodiesel fuel blends from the Fuel Injection Equipment (FIE) Manufacturers and from the Truck and Engine Manufacturers Association (EMA) at www.truckandenginemanufacturers.org.

[2] See Precautions in section 8.

2.1 Canadian General Standards Board (CGSB)

CAN/CGSB-3.0 — *Methods of testing petroleum and associated products*:

No. 28.8 — *Visual haze rating of distillate fuel oils*

No. 140.1 — *Low temperature flow test (LTFT) for diesel fuels*

CAN/CGSB-3.16 — *Mining fuel diesel* (withdrawn 2013)

CAN/CGSB-3.524 — *Biodiesel (B100) for blending in middle distillate fuels.*

2.1.1 Source

The above may be obtained from the Canadian General Standards Board, Sales Centre, Gatineau, Canada K1A 1G6. Telephone 819-956-0425 or 1-800-665-2472. Fax 819-956-5740. E-mail ncr.cgsb-ongc@tpsgc-pwgsc.gc.ca. Web site www.tpsgc-pwgsc.gc.ca/ongc-cgsb/index-eng.html.

2.2 Canadian Fuels Association

Weather Data.

2.2.1 Source

www.canadianfuels.ca/Fuels-and-Transportation/Conventional-Transportation-Fuels/.

2.3 ASTM International

Annual Book of ASTM Standards (see Annex A).

2.3.1 Source

The above may be obtained from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, U.S.A., telephone 610-832-9585, fax 610-832-9555, Web site www.astm.org, or from IHS Markit, 200-1331 MacLeod Trail SE, Calgary, Alberta T2G 0K3, telephone 613-237-4250 or 1-800-267-8220, fax 613-237-4251, Web site www.global.ihs.com.

2.4 SAE International

SAE Paper 952370 — *The Lubricity of Winter Diesel Fuels*

SAE Paper 961180 — The Lubricity of Winter Diesel Fuels — Part 2: Pump Rig Test Results

SAE Paper 981363 — *Continued Evaluation of Diesel Fuel Lubricity by Pump Rig Tests.*

2.4.1 Source

The above may be obtained from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, U.S.A., telephone 877-606-7323, fax 724-776-0790, Web site www.sae.org/servlets/index.

3 Terms and definitions

For the purposes of this National Standard of Canada, the following terms and definitions apply.

3.1
2.5% low-end design temperature
the 2.5 percentile design value is the temperature at or below which 2.5% of the hourly outside air temperatures are observed to occur for an indicated half month. The 2.5% Low-End Design Temperature for most weather stations in Canada by half month period is available on the Canadian Fuels Association Web site (see 2.2). This data is based upon an analysis of hourly weather readings from weather stations across Canada.

3.2
biodiesel
mono-alkyl esters of long-chain fatty acids derived from renewable sources. In its neat form, biodiesel is commonly designated as B100.

3.2.1
B*xx*
fuel comprised of xx percent by volume of a biodiesel mixed with diesel fuel.

3.3
biodiesel fuel blend
middle distillate fuel composed of hydrocarbons and naturally occurring, petroleum-derived non-hydrocarbons that boils in the range of 130°-400°C and that contains from 6% to 20% by volume biodiesel that is intended for use as a fuel in compression-ignition engines.

3.4
diesel fuel
middle distillate fuel composed of hydrocarbons and naturally occurring, petroleum-derived non-hydrocarbons that boils in the range of 130°–400°C and that is intended for use as a fuel in compression-ignition engines.

4 General requirements

4.1 The fuel specified shall be a blend of diesel fuel and biodiesel that may contain additives designed to improve their properties or performance, for example, diesel ignition quality, low-temperature flow properties, and electrical conductivity.

4.2 The fuel shall be a stable homogeneous liquid free from foreign matter that is likely to clog filters or nozzles, or to damage equipment.

4.3 There shall be no intentional addition of used lubricating oils, used solvents, triglycerides (such as raw vegetable oils, animal fats, fish oils or used cooking oils), or other fluids which are not normal components of the fuel.

5 Detailed requirements

For an explanation of the significance of tests and the methods used in this standard, see Annex C.

NOTE The precision statement of some of the quoted test methods in this standard may not be fully applicable.

5.1 Specified limiting values

5.1.1 The biodiesel fuel blend shall comply with the specified limiting values. The specified limiting values shall not be changed. This precludes any allowances for the test method precision and for adding or subtracting digits.

5.1.2 For purposes of determining conformance with the specified limiting values, an observed value or a calculated value shall be rounded off ‘’to the nearest unit’’ in the last right-hand digit used in expressing the specified limiting value, in accordance with the rounding-off method of ASTM E29. There is one exception (see 5.21).

5.1.3 Where test values differ between two parties, a resolution shall be in accordance with ASTM D3244 in order to determine conformance with the specified limiting values, with the criticality of the limits set at $P = 0.5$.

5.1.4 Zeroes trailing the last nonzero digit for numbers represented with a decimal point are significant digits, in accordance with ASTM E29.

5.2 Test methods

5.2.1 Test methods other than those referenced in this standard may be used only if they have been validated in accordance with ASTM D3764 or D6708.

5.2.2 Validated test methods shall correlate with methods referenced in the standard. Differences in precision, sensitivity and bias between methods referenced in the standard and the validated methods shall be noted when using results from validated methods.

5.2.3 Validated test methods shall only be used within the bounds of the data covered in their validation.

5.2.4 In the event of a dispute, the procedures given in 5.1 shall be used.

5.2.5 If parties in a dispute cannot agree on an analytical method to resolve a dispute, the method listed in the standard shall be used. Where more than one method is listed for a given detailed requirement, the referee method shall be used.

5.3 Low-temperature flow properties

5.3.1 Low-temperature flow properties of the fuel shall be designed (see 7.1) to give satisfactory performance at the temperatures indicated by the 2.5% low-end design temperature data for the period and location of intended use.

5.3.2 The following shall be reported:

a) The 2.5% low-end temperature to which the fuel is designed;

b) The test method used to determine the operability temperature:

   i) Cloud point (ASTM D2500, D5771, D5772 or D5773. In the event of a dispute, ASTM D5773 shall be the referee method.); or

   ii) Low-temperature flow test (LTFT) for diesel fuels (CAN/CGSB-3.0 No. 140.1 or ASTM D4539. In the event of a dispute, CAN/CGSB-3.0 No. 140.1 shall be the referee method).

c) The test method result.

5.4 Diesel fuel

The diesel fuel component used in the preparation of biodiesel fuel blends shall be essentially hydrocarbons (see 3.4)

	Property	Specified limiting values		
				Test method
		Min.	Max.	ASTM
5.5	Biodiesel component, % by volume, (see 5.19)	6	20.	D7371
5.6	Low-temperature flow properties, (see 5.19, 7.1)	As specified in 5.3		

	Property	Specified limiting values		
				Test method
		Min.	Max.	ASTM
5.7	Flash point[a] °C (see 5.1, 5.21, 7.2)	40.0	—	D93[b], D3828[c] or D7094
5.8	Kinematic viscosity at 40°C, mm^2/s (cSt)[d]	1.70[e]	4.10	D445[b] or D7042
5.9	Distillation, 90% recovered, °C	—	360.	D86[b] or D7345
5.10	Water and sediment, % by volume (see 5.23, 8.8)	—	0.02	D1796 (modified)[b] or D2709
5.11	Acid number, mg KOH/g (see 8.9)	—	0.14	D664 or D974[b]
5.12	Sulphur[f], mg/kg	—	15	D5453[b] or D7039
5.13	Copper strip corrosion, 3 h at a minimum test temperature of 50°C	—	No. 1	D130
5.14	Carbon residue on 10% bottoms, % by mass (see 5.24)	—	0.2	D524 or D4530[b]
5.15	Ash, % by mass	—	0.010	D482
5.16	Ignition quality, cetane number (see 7.2)	40.0	—	D613[b], D6890, D7170 or D7668
5.17	Lubricity (see 5.25 and 8.3)	As required in 5.24		—
5.18	Electrical conductivity, at point, time and temperature of delivery to purchaser, pS/m (see 8.2)	25	—	D2624

[a] A higher flash point may be specified in special applications such as marine on-board use (see Annex B, B.1). For underground mining applications, the authority having jurisdiction may specify a different flash point requirement (see Annex B, B.2).

[b] The referee method to be used in the event of a dispute.

[c] The results obtained by ASTM D3828 can be more than 2°C lower than those obtained by ASTM D93, the referee method.

[d] The SI unit for kinematic viscosity is the square metre per second. The preferred multiple for fluids in this viscosity range is the square millimetre per second, which is equivalent to a centiStokes (i.e. 1 mm^2/s = 1 cSt).

[e] If the fuel is designed for an operability temperature of -10°C or colder, then the minimum viscosity shall be 1.50 cSt. If the fuel is designed for an operability temperature of -20°C or colder, then the minimum viscosity shall be 1.30 cSt.

[f] Maximum limit may be higher for some applications when allowed by federal regulation (see Annex B, B.1.1.3)

5.19 Biodiesel component

The biodiesel component (see 3.2) shall comply with CAN/CGSB-3.524.

5.19.1 A minimum level of 6% by volume of biodiesel is specified to differentiate this standard from related standards.

5.19.2 Percentage concentrations of biodiesel (B*xx*) shall be expressed in whole numbers, such as 10% by volume biodiesel (see 5.19.1 and 5.5).

5.19.3 When reporting the concentration of the biodiesel used to prepare a blend, metered (measured) volumes may be used in place of analytical tests when the component is added. Biodiesel content may also be tested using ASTM D7371.

5.19.4 Blending of biodiesel and the diesel fuel component shall be performed so that the final blend is homogeneous.

5.20 Kinematic viscosity

Only bias-corrected values from ASTM D7042 may be used as an alternate to ASTM D445.

5.21 Flash point

The test values determined in accordance with ASTM D93, D3828 or D7094 shall be reported to the nearest 0.5°C (see 8.2).

5.22 Distillation

Testing shall be in accordance with ASTM D86 or D7345. Only bias-corrected values from ASTM D7345 may be used as an alternate to ASTM D86. In the event of a dispute, the automated method of ASTM D86 shall be the referee test method.

5.23 Water and sediment

Testing shall be conducted in accordance with ASTM D1796 (modified) or D2709. The test in ASTM D1796 shall be modified by substituting the centrifuge tube specified in ASTM D2273 for that in ASTM D1796. In the event of a dispute, ASTM D1796 (modified) shall be the referee test method.

5.24 Carbon residue

Testing may be performed prior to the addition of any additives to the fuel.

5.25 Lubricity requirements

Either the diesel fuel (see 5.4) or the finished biodiesel fuel blend shall provide **acceptable** lubricity performance in accordance with **any one** of the following criteria:

5.25.1 Pump wear with a representative fuel in a distributor-type diesel fuel injection pump in a vehicle field test

The required vehicle field test methodology is described in SAE Paper 952370. An acceptable pump-wear result is defined as an overall pump rating of 4.0 or less using the rating method described in SAE Paper 961180.

5.25.2 Pump wear with a representative fuel in a distributor-type diesel fuel injection pump rig test

The required pump rig test methodology is described in SAE Paper 981363. SAE Papers 961180 and 952370 provide additional background information. An acceptable pump-wear result is defined as an overall pump rating of 4.0 or less using the rating method described in SAE Papers 981363 and 961180.

5.25.3 Lab bench test results with a representative fuel using the high frequency reciprocating rig test

The required high frequency reciprocating rig test is described in ASTM D6079 and D7688, and shall be run at 60°C. An acceptable test result is defined as a wear scar diameter of less than, or equal to, 460 µm at 60°C. In the event of a dispute, ASTM D7688 shall be the referee test method for this criterion.

6 Inspection

6.1 Sampling

6.1.1 Sampling equipment and procedures shall be designed and used to obtain representative samples of a product. Sampling lines, hoses, etc. should be adequately flushed prior to taking a sample. Samples should be stored in a cool, dark place. Procedures shall be in accordance with ASTM D4057, D4177 or D5854.

6.1.2 Sample volume should be consistent with the requirement of the testing laboratory or the authority having jurisdiction or both. Unless otherwise specified (see 7.2), a sample of at least 2.7 L shall be collected.

7 Options

7.1 The following option shall be specified in the application of this standard:

a) Low-temperature design requirements for period and location of intended use (see 5.3).

7.2 The following options may be specified if the requirements are more stringent than those stipulated in this standard:

a) Flash point (see 5.7)

b) Cetane number (see 5.16)

c) Sample size (see 6.1.2).

8 Precautions

8.1 General properties

The properties of a biodiesel fuel blend can be significantly different from those of the diesel fuel component when the biodiesel component concentration is greater than 5% by volume.

8.2 Conductivity depletion

Due to the normal depletion of fuel conductivity during commingling, storage, and distribution, or at low temperatures, the fuel should be sufficiently treated with conductivity-improver additive to ensure that the electrical conductivity requirement in 5.18 is met. The temperature at the point of use and the method of distribution could require a substantially higher conductivity level than 25 pS/m at the point of additive treatment. For more information, refer to Annex C, C.14, ASTM D4865 and D2624.

NOTE Negative interactions can occur between some biodiesels and conductivity additive.

8.3 Fuel lubricity

Some processes that are used to desulphurize diesel fuel, if severe enough, can also reduce the natural lubricating qualities of the diesel fuel. Most biodiesels exhibit very good lubricity. Since diesel injection systems require the fuel to act as a lubricant, the fuel shall have sufficient lubricity to give adequate protection against excessive fuel injection system wear. Additives are available that can improve diesel fuel lubricity. Lubricity additives can have unwanted side effects, particularly when used at excessive concentrations or in combination with other additives. Adding over 1% by volume of biodiesel generally results in acceptable lubricity.

8.4 Heating oil application

At times diesel fuel can be used in a heating oil application. Acceptability of biodiesel fuel blends in the range of this standard, however, has not been established for heating oil applications.

8.5 Manufacturing processes

Contamination from manufacturing processes or treatments can be carried over in trace quantities into the biodiesel fuel blend and cause unexpected problems. Moreover, these contaminants might not be detected by the requirements listed in this standard. It is recommended that adequate quality assurance procedures be put in place to ensure that manufacturing processes capable of such contamination are identified and controlled. Sodium, calcium, chlorides, sulphates, clay, sand, acids, caustic, soaps, and amine process additives are examples of possible contaminants or potential precipitates.

8.6 Visual haze

The solubility of water in fuel is a function of temperature. When fuel is exposed to low ambient temperatures, water can separate and cause a hazy or cloudy appearance. It has been a common industry practice to perform the visual haze test at 4°C for fuel destined for use in winter and at 15°C for fuel destined for use in summer. Experience has indicated that fuel passing these requirements has been acceptable in the appropriate season. For more information on the visual haze test, refer to CAN/CGSB-3.0 No. 28.8, or to ASTM D4176, Procedure 2.

8.7 Material incompatibility of biodiesel

Biodiesel is incompatible with some elastomer materials that are used in diesel fuel injection systems. The use of B6-B20 biodiesel fuel blends can result in problems with some fuel system components, more likely in older engine systems. Corrosion of some non-ferrous metals can result, particularly when free water is present in the biodiesel fuel blend. Biodiesel fuel blends can also soften and remove paint from finished surfaces.

8.8 Impact of free water on storage and handling of biodiesel fuel blends

In the presence of free water, biodiesel can be more vulnerable to degradation than conventional petroleum-derived diesel fuel. See Annex C, C.15 for guidance on storage and handling, and ASTM D6469 for information on microbial contamination.

8.9 Impact of biodiesel on acid number

Biodiesels, as produced, can have acid numbers up to 0.5 mg KOH/g, whereas ultra-low sulphur diesel fuels usually have very low acid numbers. Generally when the acid number of conventional, petroleum-derived diesel fuel reaches an acid number of 0.10 mg KOH/g, degradation has commenced and the fuel can be unsuitable for engine use due to the formation of gums, varnishes and sludges. Available data indicates that biodiesel with higher acid numbers can be less stable and lead to more rapid degradation in storage or service. See Annex C, C.12 for further information.

8.10 Impact of biodiesel on stability

Manufacturers of diesel fuel injection equipment and diesel engines have concerns with the degradation of biodiesel fuel blends when equipment designs expose the fuel to high temperatures. Fuel blends with poor stability can lead to problems such as filter plugging, sediment formation and lacquering of fuel injection equipment. Note that there is a stability requirement for the biodiesel component (CAN/CGSB-3.524). See Annex C, C.19.3 and C.19.4 for further information.

8.11 Impact of biodiesel use for infrequent operation

Biodiesel fuel blends should be consumed within six months of production and therefore should not be used in engines that operate infrequently, such as emergency electrical generators, or lifeboats (see Annex C, C.19).

8.12 Initial use of biodiesel fuel blends

The higher solvency of biodiesel compared to conventional diesel fuel can dislodge some deposits in fuel systems. Fuel systems, including storage tanks and vehicle/equipment tanks and lines that have been in conventional diesel fuel service for some time, should be thoroughly cleaned prior to the introduction of biodiesel fuel blends. Debris dislodged by initial use of biodiesel fuel blends has resulted in the plugging of fuel filters and strainers, sometimes requiring numerous filter changes and other operational difficulties. Filter type shall be compatible with biodiesel blends.

8.13 Fuel flammability

A number of properties shall be considered in assessing the overall flammability hazard of a fuel. Flash point is the minimum fuel temperature at which a mixture of air and fuel vapour can form and be ignited by a spark or flame under specified laboratory conditions. However, the flash point is only an indication of the potential flammability risk of a fuel. Oxygen concentration in the atmosphere is an additional factor affecting flammability. Investigation of fuel-related fires in marine vessel engine rooms and underground mining applications has shown that these fires are generally initiated through direct contact of a fuel spray or spill with hot surfaces having a temperature exceeding the auto-ignition temperature of the fuel. The flash point of the fuel has little bearing on the probability of such fires occurring. Similarly, fires in fuel tanks are typically initiated as a result of hot work (e.g., welding) on the exterior surface of the tank causing fuel adhering to the interior tank wall surface to evaporate and spontaneously ignite after having exceeded its auto-ignition temperature.

Annex A
(normative)

Referenced ASTM International publications (see 2.3)

Annual Book of ASTM Standards

D86 Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure

D93 Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

D130 Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

D445 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D482 Standard Test Method for Ash from Petroleum Products

D524 Standard Test Method for Ramsbottom Carbon Residue of Petroleum Products

D613 Standard Test Method for Cetane Number of Diesel Fuel Oil

D664 Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration

D974 Standard Test Method for Acid and Base Number by Color-Indicator Titration

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

D2273 Standard Test Method for Trace Sediment in Lubricating Oils

D2500 Standard Test Method for Cloud Point of Petroleum Products

D2624 Standard Test Methods for Electrical Conductivity of Aviation and Distillate Fuels

D2709 Standard Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge

D2887 Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography

D3244 Standard Practice for Utilization of Test Data to Determine Conformance with Specifications

D3764 Standard Practice for Validation of the Performance of Process Stream Analyzer Systems

D3828 Standard Test Methods for Flash Point by Small Scale Closed Cup Tester

D4057 Standard Practice for Manual Sampling of Petroleum and Petroleum Products

D4176 Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedure)

D4177 Standard Practice for Automatic Sampling of Petroleum and Petroleum Products

D4530 Standard Test Method for Determination of Carbon Residue (Micro Method)

D4539 Standard Test Method for Filterability of Diesel Fuels by Low-Temperature Flow Test (LTFT)

D4865 Standard Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems

D5453 Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence

D5771 Standard Test Method for Cloud Point of Petroleum Products (Optical Detection Stepped Cooling Method)

D5772 Standard Test Method for Cloud Point of Petroleum Products (Linear Cooling Rate Method)

D5773 Standard Test Method for Cloud Point of Petroleum Products (Constant Cooling Rate Method)

D5854 Standard Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products

D6079 Standard Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)

D6708 Standard Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that Purport to Measure the Same Property of a Material

D6469 Standard Guide for Microbial Contamination in Fuels and Fuel Systems

D6890 Standard Test Method for Determination of Ignition Delay and Derived Cetane Number (DCN) of Diesel Fuel Oils by Combustion in a Constant Volume Chamber

D7039 Standard 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 Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

D7094 Standard Test Method for Flash Point by Modified Continuously Closed Cup (MCCCFP) Tester

D7170 Standard Test Method for Determination of Derived Cetane Number (DCN) of Diesel Fuel Oils – Fixed Range Injection Period, Constant Volume Combustion Chamber Method

D7345 Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure (Micro Distillation Method)

D7371 Standard Test Method for Determination of Biodiesel (Fatty Acid Methyl Esters) Content in Diesel Fuel Oil Using Mid Infrared Spectroscopy (FTIR-ATR-PLS Method)

D7668 Standard 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

D7688 Standards Test Methods for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR) by Visual Observation

E29 Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications.

Annex B
(informative)

Federal, provincial and other regulations applicable to diesel fuels[3, 4, 5]

B.1 Federal regulations

B.1.1 Canadian Environmental Protection Act

The following federal regulations have been enacted under the *Canadian Environmental Protection Act*: 1999.

B.1.1.1 Fuels Information Regulations, No. 1 (C.R.C. c. 407 amended by SOR/DORS/79-280, 80-138 and 2000-104)

These regulations require producers and importers to submit information on sulphur and additive contents (other than lead) of liquid fuels.

B.1.1.2 Contaminated Fuel Regulations (SOR/DORS/91-486)

These regulations prohibit the importation of fuels that have been contaminated with hazardous wastes.

B.1.1.3 Sulphur in Diesel Fuel Regulations (SOR/DORS/2002-254)

These regulations define the sulphur limits for fuels used in diesel engines.

B.1.1.4 Renewable Fuels Regulations (SOR/DORS/2010-189)

These regulations define the renewable fuel content requirements for gasoline, diesel and heating oil.

B.1.2 The following federal regulations also apply to fuels meeting this standard:

B.1.2.1 Marine Machinery Regulations (SOR 90/264)

These regulations, enacted under the *Canada Shipping Act, 2001*, specify details related to the construction, installation and inspection of marine machinery. Safety requirements for diesel fuels used in marine applications are also specified.

B.1.2.2 Transportation of Dangerous Goods Regulations (SOR/DORS/2001-286)

These regulations, enacted under the *Transportation of Dangerous Goods Act, 1992*, give detailed packaging, labelling and documentation requirements for transporting fuels in Canada.

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[3] The regulations listed are subject to revision by the relevant authority. The user should consult the relevant authority to confirm the current regulations. The information provided about the regulations is for information only. In case of conflict, the text of the regulation takes precedence.

[4] The requirements in jurisdictions other than those listed above will be added, as information becomes available in future revisions or amendments to this standard or both.

[5] This list is provided for information only and may not be complete. Please advise the CGSB of any other regulation that could apply on this standard.

B.2 Provincial regulations

B.2.1 Alberta

B.2.1.1 **Renewable Fuels Standard Regulation** (Alta. reg. 29/2010)

This regulation, enacted under the *Climate Change and Emissions Management Act*, defines the requirements for renewable fuels in Alberta.

B.2.1.2 **Mines Safety Regulation** (Alta. reg. 292/1995)

This regulation, enacted under the *Occupational Health and Safety Act*, specifies diesel fuel requirements for underground mining applications.

B.2.2 British Columbia

B.2.2.1 **Renewable and Low Carbon Fuel Requirements Regulation** (B.C. reg. 394/2008)

This regulation, enacted under the *Greenhouse Gas Reduction (Renewable and Low Carbon Fuel Requirements) Act*, defines the requirements for renewable fuels in British Columbia.

B.2.2.2 **Occupational Health and Safety Regulation** (B.C. reg. 296/97)

This regulation, enacted under the *Workers Compensation Act*, specifies diesel fuel requirements for underground mining applications.

B.2.3 Manitoba

B.2.3.1 **Storage and Handling of Petroleum Products and Allied Products Regulation** (Man. reg. 188/2001)

This regulation, enacted under the *Dangerous Goods Handling and Transportation Act*, specifies requirements for fuel intended for sale in Manitoba for use in internal combustion engines.

B.2.3.2 **Biodiesel (General) Regulation** (Man. reg. 178/2008)

This regulation defines the quality requirements for biodiesel and biodiesel blended with diesel in Manitoba. The regulation is available at the following address www.canlii.org/mb/laws/regu/2001r.188/index.html.

B.2.3.3 **Biodiesel Mandate for Diesel Fuel Regulation** (Man. reg. 147/2009)

This regulation defines the volume requirements for biodiesel content in diesel in Manitoba.

B.2.3.4 **Operation of Mines Regulation** (Man. reg. 228/94)

This regulation, enacted under the *Workplace Safety and Health Act*, specifies diesel fuel requirements for underground mining applications.

B.2.4 New Brunswick

B.2.4.1 **Underground Mine Regulation** (N.B. reg. 96-105)

This regulation, enacted under the *Occupational Health and Safety Act*, specifies diesel fuel requirements for underground mining applications.

B.2.5 Newfoundland and Labrador

B.2.5.1 **Mines Safety of Workers Regulations** (C.N.L.R. 1145/96)

These regulations, enacted under the *Occupational Health and Safety Act*, specify diesel fuel requirements for underground mining applications.

B.2.6 Northwest Territories

B.2.6.1 **Mine Health and Safety Regulations** (N.W.T. reg. 125-95)

These regulations, enacted under the *Mine Health and Safety Act*, specify diesel fuel requirements for underground mining applications.

B.2.7 Nova Scotia

B.2.7.1 **Underground Mining Regulations** (N.S. reg. 153/2003)

These regulations, enacted under the *Occupational Health and Safety Act*, specify diesel fuel requirements for underground mining applications.

B.2.8 Nunavut

B.2.8.1 **Mine Health and Safety Regulations** (N.W.T. (Nu.) reg. 125-95)

These regulations, enacted under the *Mine Health and Safety Act*, specify diesel fuel requirements for underground mining applications.

B.2.9 Ontario

B.2.9.1 Liquid Fuels Handling Code, 2007

This code, published by *the Technical Standards and Safety Authority* and adopted by reference under the *Technical Standards and Safety Act, 2000*[6], specifies safety related requirements for handling liquid fuels.

B.2.9.2 **Mines and Mining Plants** (R.R.O. 1990, reg. 854)

This regulation, enacted under the *Occupational Health and Safety Act*, specifies diesel fuel requirements for underground mining applications.

B.2.9.3 **Greener Diesel — Renewable Fuel Content Requirements for Petroleum Diesel Fuel** (Ontario regulation 97/14)

This regulation, enacted under the *Environmental Protection Act*, defines the requirements for renewable fuels in Ontario.

[6] Available from Service Ontario Publications, Toronto, Canada, telephone 1-800-668-9938, fax 613-545-4223. Also available on-line at www.publications.serviceontario.ca/.

B.2.10 Quebec

B.2.10.1 General requirements

The general requirements are controlled under the latest version of the *Loi sur les produits pétroliers*, R. L. R. Q., c. P-30.01, *Règlement sur les produits pétroliers*, D.581-2015, G.O. 28, 2147 or *Petroleum Products Act*, R.S.Q., c. P-30.01, *Petroleum Products Regulation*, Q.C. 581-2015, G.O. 28,1375[7]. This regulation lists Quebec quality requirements for aviation gasolines, aviation turbine fuels, automotive gasolines, gasolines containing denatured fuel ethanol for use in automotive spark ignition fuels, diesel fuels, diesel fuels containing biodiesel (B100) for blending in middle distillate fuels, fuel oil types 0, 1 and 2, and fuel oil types 4, 5 and 6. Amendments and editions published apply only 90 days after the last day of the month that the French text of the amendments or editions was published. The Direction générale des hydrocarbures et des biocombustibles of the ministère de l'Énergie et des Ressources naturelles is responsible for the application and revision of this regulation. Web site www.mern.gouv.qc.ca/english/energy/index.jsp.

B.2.10.2 **Regulation Respecting Occupational Health and Safety in Mines** (R.R.Q., c. S-2.1, r. 14)

This regulation, also known as *Règlement sur la santé et la sécurité du travail dans les mines*, was enacted under *An Act respecting Occupational health and safety* and specifies diesel fuel requirements for underground mining applications.

B.2.11 Saskatchewan

B.2.11.1 **Mines Regulations, 2003** (R.R.S. c. O-1.1 reg. 2)

These regulations, enacted under the *Occupational Health and Safety Act, 1993*, specify diesel fuel requirements for underground mining applications.

B.2.12 Yukon

B.2.12.1 **Mine Safety Regulations** (Y.O.I.C. 1986B/164)

These regulations, enacted under the *Occupational Health and Safety Act*, specify diesel fuel requirements for underground mining applications.

[7] Available from Les Publications du Québec. Telephone 1-800-463-2100 or 418-643-5150. Fax 1-800-561-3479 or 418-643-6177. Also available on-line at www2.publicationsduquebec.gouv.qc.ca/home.php.

Annex C
(informative)

Significance of requirements for B6-B20 biodiesel fuel blends

C.1 Introduction

C.1.1 The properties of commercial diesel fuels depend on the refining practices employed and the nature of the crude oils from which they are produced. For example, diesel fuel produced within the boiling range of 130°-400°C may have many possible combinations of various properties such as volatility, ignition quality, viscosity and other characteristics.

C.1.2 Biodiesel typically has a narrow distillation range. It is normally produced by a reaction of a vegetable oil (such as soybean or canola oil), or an animal fat with an alcohol (such as methyl alcohol) in the presence of a catalyst. This reaction produces mono-alkyl esters and glycerol (glycerin). Most of the glycerol and excess alcohol are then removed from the biodiesel fuel component.

C.1.3 Biodiesel is an oxygenate because it contains oxygen in the ester functional group. The polar nature of long-chain alkyl ester molecules, due to the ester functional group, accounts for the differences between certain properties of the biodiesel component and those of hydrocarbon diesel fuel. For example, esters (and alcohol impurities) have higher solubility for water that can raise conductivity and act as electrolytes, which can accelerate corrosion.

C.1.4 The energy content of biodiesel (B100) is typically 8% to 11% less than that of petroleum diesel fuel on a volumetric basis. Thus biodiesel fuel blends B*xx* can have proportionately lower volumetric energy content, depending on the percentage of biodiesel.

C.2 B6-B20 Biodiesel fuel blends

C.2.1 CAN/CGSB-3.522 is intended as a statement of permissible limits of significant fuel properties used for specifying the wide variety of commercially available ultra-low sulphur diesel fuels that may be combined with 6% to 20% by volume of biodiesel. Refer to the *Sulphur in Diesel Fuel Regulations* for limits and timing. Limiting values of significant properties are prescribed for one class of diesel fuel that contains from 6% to 20% by volume of biodiesel.

C.2.1.1 Biodiesel fuel blends conforming to this standard are intended for use in high-speed diesel engine systems that are specifically designed for, or are converted to be compatible with, biodiesel blends in the range of 6% to 20% by volume of biodiesel in services involving relatively high loads and uniform speeds. While B20 **has** been used in a variety of makes and models of diesel engines that manufacturers **have not** identified as suitable for use with fuels of more than 5% biodiesel, such applications face a higher risk of potential problems in the fuel systems, emission control devices and auxiliary devices. Refer to the owner's manual or specific information from the original equipment manufacturer for additional guidance.

C.2.1.2 While diesel fuel that complies with CAN/CGSB-3.517[8] Type A may be used as the diesel fuel component in biodiesel fuel blends, this standard does not provide specifications for biodiesel blends based on Type A fuel. This is because diesel fuel blends containing 6% to 20% biodiesel will exceed the 90% distillation temperature maximum of 290°C for a Type A diesel fuel. Additionally these B6–B20 fuel blends generally have very poor low temperature operability and so are not suitable substitutes for Type A.

C.2.2 CAN/CGSB-3.520[9] is a parallel standard containing from 1.0 to 5% by volume of biodiesel.

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[8] CAN/CGSB-3.517 — Diesel fuel.

[9] CAN/CGSB-3.520 — Diesel fuel containing low levels of biodiesel (B1–B5).

C.2.3 CAN/CGSB-3.517[10] is a parallel standard without a biodiesel component.

C.2.4 The maximum concentration limit of 20% by volume of biodiesel is based upon existing experience with biodiesel fuel blends, mostly in the United States. Higher concentrations of biodiesel, such as 30%, have been used in limited applications in France, and 100% rapeseed methyl ester has been used in Germany and Austria. Some engine manufacturers allow the use of 30% to 100% biodiesel in specific engine models.

C.3 Selection of a particular biodiesel fuel blend

The selection of a particular biodiesel fuel blend for use in a given engine requires consideration of the following factors:

a) Legal requirements

b) Expected outside air temperatures

c) Availability

d) Maintenance frequency and requirements

e) Engine size and design

f) Speed and load changes

g) Frequency of speed and load changes

h) Engine manufacturer's recommendations and fuel specifications.

Some of these factors may influence the required fuel properties outlined as follows:

C.4 Flash point

C.4.1 The flash point as specified is not directly related to engine performance. It is, however, of importance in connection with legal requirements, such as the *Transportation of Dangerous Goods Regulations*, and safety precautions involved in fuel handling and storage. It is normally specified to meet insurance and fire regulations.

C.4.2 The flash point of biodiesel is higher than that of diesel fuels. However, the actual flash point of a biodiesel can be related to the concentration of alcohol remaining after its production. CAN/CGSB-3.524 allows the use of flash point to limit the remaining alcohol in the biodiesel

C.5. Ignition quality: Cetane number and calculated cetane index

C.5.1 Cetane number as determined in ASTM D613 is a measure of the ignition quality of the fuel, and influences combustion characteristics. The cetane number requirements depend on engine design and size, nature of speed and load variations, and starting and atmospheric conditions. Higher cetane number fuels generally give better performance in aspects such as cold startability, reduced white smoke after start-up and lower combustion noise.

C.5.2 The calculated cetane index is a useful technique for approximating the cetane number of diesel fuels that do **not** contain a cetane improver additive or biodiesel. The calculated cetane index should **not** be used to approximate the cetane number of biodiesel blends. There is no published model to support the calculation of a cetane index with biodiesel or biodiesel fuel blends.

C.5.3 Test methods ASTM D6890, D7170 and D7668, which give a derived cetane number, are applicable to biodiesel fuel blends.

[10] Fuel meeting standard CAN/CGSB-3.517 may be used for applications that were formerly covered by CAN/CGSB-3.6-2010.

C.6 Viscosity and lubricity

C.6.1 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, fuel temperature and the characteristics of the injection system (such as fuel pumps, injectors and filters or screens).

C.6.2 For some engines, diesel fuel is a lubricant for the injection system, therefore, it must have sufficient lubricity to ensure fuel system durability and hence emission durability requirements. Diesel fuel lubricity can be defined as the ability of a fuel to prevent or minimize wear in diesel fuel injection equipment.

C.7 Distillation

C.7.1 Fuel volatility requirements depend on engine design and size, the nature of speed and load variations, as well as starting and atmospheric conditions. For engines in services involving rapidly fluctuating loads and speeds, as in bus and truck operations, the more volatile fuels with a lower percentage of biodiesel component might provide better performance under some conditions.

C.7.2 Some biodiesel, depending on feedstock source, can have a high boiling point, which can give a 90% distillation temperature of a biodiesel fuel blend above the 90% distillation temperature of the petroleum diesel fuel component, and even above 360°C. Biodiesel has a narrow boiling range, typically between 300°-400°C. Adding biodiesel to a conventional Type A or Type B diesel fuel can raise the 90% distillation temperature. This property should be considered because of the limit of 360°C for the 90% distillation temperature that is based on Canadian experience with petroleum diesel fuel.

C.8 Carbon residue

Carbon residue is a measure of the carbon-depositing tendencies of a diesel fuel after evaporation and pyrolysis under prescribed conditions. While not directly correlating with engine deposits, this property can be considered a guide.

C.9 Sulphur

The use of sulphur levels higher than 15 mg/kg can contribute to the weight of particulates in the exhaust and can have a deleterious effect on catalytic after-treatment systems. Diesel fuel with a maximum sulphur level of 15 mg/kg is required to ensure compatibility with exhaust after-treatment technology of modern diesel-powered equipment.

C.10 Low-temperature operability

C.10.1 Low-temperature operability of diesel fuel and biodiesel fuel blends can be defined by either cloud point or low-temperature flow tests or some combination thereof.

C.10.2 Cloud point defines the temperature at which a cloud or haze of wax crystals appears in the fuel under prescribed test conditions. It is the most common measure of low-temperature operability.

C.10.3 The low-temperature flow test was developed in order to predict low-temperature operability of fuels to which a wax crystal modifier has been added. A cloud point test on such additized fuels will not accurately measure the operability limit of the fuel due to the use of these additives.

C.10.4 The low-temperature operability of biodiesel fuel blends can ***limit availability*** in some ***jurisdictions and seasons***. Biodiesel components typically have relatively high cloud points (-5° to +15°C), depending on the source of the feedstock. The addition of up to 20% biodiesel to a diesel fuel can significantly degrade the low-temperature operability of the biodiesel fuel blend relative to the low-temperature properties of the petroleum diesel fuel component.

C.10.5 The viscosity of a fuel blend will increase under cold ambient temperatures. In some situations the fuel's viscosity can be the limiting low-temperature operability factor as opposed to wax formation in the fuel.

C.10.6 Precipitation of biodiesel fuel blend components above the cloud point has been reported, and is more likely if the fuel is stored for an extended period at low temperatures, or if it experiences temperatures below the cloud point during storage or handling, and if it is wet or dirty.

C.11 Ash

C.11.1 Ash-forming materials can be present in diesel fuels as abrasive solids and soluble metallic soaps. Abrasive solids can contribute to injector, fuel pump, piston and ring wear, and also to engine deposits. Soluble metallic soaps have little effect on wear but can contribute to engine deposits.

C.11.2 CAN/CGSB-3.524 limits contamination by alkali metals resulting from catalysts used in esterification processes by directly limiting Na, K, Ca and Mg.

C.12 Acidity

C.12.1 There is directional evidence that acidic fuels can have poorer stability, may cause increased corrosion of mild steel, and could cause deposit formation in some types of fuel injection equipment.

C.12.2 Biodiesel, as manufactured, typically has a higher acid number than diesel fuel. This is due to the presence of long-chain fatty acids that are not as corrosive as simple organic acids such as formic and acetic acid. The latter acids can be formed by oxidative degradation of biodiesel.

C.13 Copper strip corrosion

This test serves as a measure of possible corrosion of copper, brass or bronze parts in the fuel system due to corrosive sulphur species.

C.14 Electrical conductivity

The ability of a fuel to dissipate electric charge that has been generated during pumping and filtering operations is controlled by its conductivity. If a fuel's conductivity is sufficiently high, the static electric charge dissipates fast enough to prevent its accumulation, so that dangerously high electrical potentials are avoided.

C.15 Recommended practices for the storage and handling of biodiesel fuel blends

C.15.1 Recommended practices for storage and blending with diesel fuel to ensure precipitation does not occur in the finished fuel due to temperature, solubility, moisture and concentration effects are available as follows:

C.15.1.1 Guidelines for handling and blending FAME (CONCAWE report No. 9/09), available as a PDF at www.concawe.org.

C.15.1.2 Biodiesel Handling and Use Guide, Fourth edition 2009 NREL/TP-540-43672, National Renewable Energy Laboratory, available electronically at http://www.nrel.gov/docs/fy09osti/43672.pdf.

C.15.2 Fuels should be stored under cool, clean, dry conditions. Free water should regularly be drained from storage tanks and filter housings.

C.15.3 It is especially important to store biodiesel fuel blends under clean, dry and cool conditions. Biodiesel fuel blends are *more* susceptible to microbial attack. This risk can be reduced by good housekeeping and ensuring that storage tanks are regularly drained to keep them dry. For more information on microbial contamination, refer to ASTM D6469.

C.15.4 Organic sediment can appear in fuels in long-term storage. Filtration is recommended prior to use.

C.15.5 Where long-term storage of biodiesel fuel blends is contemplated, use of stability additives (e.g. anti-oxidants, metal deactivators and dispersants) should be considered. The fuel supplier should be consulted.

C.15.6 Users of biodiesel fuel blends are advised to be cautious of storing blended fuel for an extended period of time. A good practice would be not to exceed six month's storage.

C15.7 Fuel storage containers and tanks should be opaque. Some translucent (plastic) tanks exposed to light have proven to be unsatisfactory for the storage of fuels.

C.15.8 When blending biodiesel and diesel fuel, each should be at least 5°C above their respective cloud point to prevent precipitation of trace components from some biodiesels. Such precipitates might not re-dissolve, and can plug filters on fuel dispensers or equipment. The blend of the two components should also be homogeneous. "Splash blending" or sequential blending of components can result in heterogeneous (non-uniform) batches of product, resulting in some product having very high concentrations of biodiesel, and some product having little or none.

C.15.9 Filter plugging problems

A number of contaminants in some biodiesels have relatively low solubility in diesel fuel and can precipitate from fuel blends, sometimes in a non-reversible manner. This includes sterol glucosides and some saturated monoglycerides. Exposure to cold temperatures over time can accelerate this precipitation and the formation of larger agglomerates. These can settle in the bottom of storage tanks and plug filters.

C.15.10 Low temperature bulk storage

Exercise caution if biodiesel fuel blends have experienced temperatures below -15°C as precipitates can occur in bulk storage.

C.16 Used lubricating oils or extraneous fluids

Used lubricating oils, extraneous fluids, unconverted triglycerides (such as raw vegetable oils, animal fats, fish oil and used cooking oils) are not suitable components for use in biodiesel fuel blends. The addition of these materials to fuel blends can increase exhaust emissions, increase wear of engine components such as injectors, increase deposits in the engine, and cause premature fuel filter plugging.

C.17 Thermal stability

C.17.1 Heat transfer is a design function of diesel fuels in many modern diesel engines. Only a portion of the fuel that is circulated and pressurized by the fuel injection system is actually combusted. The remainder of the fuel is recycled back to the fuel tank. The bulk fuel temperature can be well above ambient levels. Inadequate high-temperature stability of a diesel fuel can result in the formation of insoluble degradation products that can then cause filter plugging.

C.17.2 ASTM D6468[11] can be used to measure diesel fuel thermal stability. A higher percentage reflectance rating in this test indicates better thermal stability and a reduced tendency to cause filter plugging.

C.18 Fuel colour

While this standard does not have a colour requirement, colour can be a useful indicator of fuel quality or contamination. Normally, fuel colour ranges from water white (colourless) to an amber or light brownish colour depending on crude oil type or refinery processes. Fuel in long-term storage can darken, due to oxidation of trace components, but this will not affect its performance. If the darkening is accompanied by the formation of sediment, however, the fuel could be rendered unacceptable for use. Fuels having unusual shades of colour should be investigated to determine fitness for use.

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[11] ASTM D6468 — Standard Test Method for High Temperature Stability of Middle Distillate Fuels.

C.19 Biodiesel component in biodiesel fuel blends

C.19.1 In meeting the requirements of CAN/CGSB-3.524, the precision and bias statements for some ASTM test methods specified therein are unknown for the biodiesel component.

C.19.2 Composition

High levels of free glycerine and mono-, di- and tri-glycerides in the biodiesel component can cause injector deposits and filter plugging, as well as adversely affect low temperature operability. CAN/CGSB-3.524 has established performance requirements to minimize these problems.

C.20 Stability

C.20.1 Concerns exist with the stability and deposit forming tendencies of biodiesel fuel blends. Some users have indicated that the stability of biodiesel blends can be a concern, and issues such as filter plugging, sediment formation and lacquering of fuel injection equipment have been encountered. Some diesel engine manufacturers have expressed concerns about the thermal stability of biodiesel fuel blends in engine designs that expose the fuel to high temperatures and pressures.

C.20.2 ASTM D6751[12] contains a stability requirement of 3 h by EN 15751[13], (the Rancimat stability test), the European biodiesel fuel standard, EN 14214[14], requires a minimum 8.0 h induction period by EN 14112[15] or EN 15751, and CAN/CGSB-3.524 requires a minimum of 8 h by EN 14112. In this test method, fuel is thermally stressed (110°C in the presence of oxygen) and the generation of volatile acids (collected by sparging through water) is determined by conductance. Users of biodiesel blends can also consider evaluating the product by tests such as ASTM D5304[16], ASTM D6468, ASTM D7462[17] and ASTM D7545[18].

C.20.3 If a sample of biodiesel fuel blend is being collected for stability testing, use sample containers that will not affect the stability properties of biodiesel blends. Containers should have an inert coating (e.g. epoxy or polytetrafluoroethylene – PTFE) or be dark bottles of “neutral glass”. Some plastic bottles can contain anti-oxidants that can be extracted by esters, affecting the results of stability tests on samples. Consult ASTM D4306[19] or IP 306[20] for guidance. Test should be conducted as soon as possible or a nitrogen blanket is recommended.

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[12] ASTM D6751 — Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels.

[13] EN 15751— Automotive fuels — Fatty acid methyl ester (FAME) fuel and blends with diesel fuel — Determination of oxidation stability by accelerated oxidation method.

[14] EN 14214 — Automotive fuels — Fatty acid methyl esters (FAME) for diesel engines — Requirements and test methods (includes Amendment A1: 2009).

[15] EN 14112— Fat and oil derivatives — Fatty acid methyl esters (FAME) — Determination of oxidation stability (accelerated oxidation test).

[16] ASTM D5304 — Standard Test Method for Assessing Middle Distillate Fuel Storage Stability by Oxygen Overpressure.

[17] ASTM D7462 — Standard Test Method for Oxidation Stability of Biodiesel (B100) and Blends of Biodiesel with Middle Distillate Petroleum Fuel (Accelerated Method).

[18] ASTM D7545 — Standard Test Method for Oxidation Stability of Middle Distillate Fuel, Rapid Small Scale Oxidation Test (RSSOT).

[19] ASTM D4306 — Standard Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination.

[20] IP 306 — Oxidation Stability of Straight Mineral Oil, published by the Energy Institute (www.energyinst.org.uk), may be obtained from: Portland Customer Services, Commerce Way, Whitehall Industrial Estate, Colchester CO2 8HP, UK; Tel: +44(0) 1206 796 351; Fax: + 44(0)1206 799 331; Email: sales@portland-services.com. Web site: www.portlandpress.com.