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National Standard of Canada

Biodiesel (B100) for blending in middle distillate fuels

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Biodiesel (B100) for blending in middle distillate fuels

1 Scope

This standard applies to one grade of biodiesel that is intended for use as a blending component in middle distillate fuels.

Biodiesel meeting this standard is not intended for use as a fuel in its neat form.

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 standard. A dated reference is to the specified revision or edition of the reference or document in question.

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 liquid fuels
- No. 142.0 Cold soak filter blocking tendency of biodiesel (B100).

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 ASTM International

Annual Book of ASTM Standards (see Annex A).

2.2.1 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.

2.3 European Committee for Standardization (CEN)

EN 14107 — Fat and oil derivatives. Fatty acid methyl esters (FAME). Determination of phosphorous content by inductively coupled plasma (ICP) emission spectrometry

EN 14110 — Fat and oil derivatives. Fatty acid methyl esters (FAME). Determination of methanol content

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

EN 14538 — Fat and oil derivatives. Fatty acid methyl ester (FAME). Determination of Ca, K, Mg and Na content by optical emission spectral analysis with inductively coupled plasma (ICP OES)

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

2.3.1 Source

The above may be obtained from the European Committee for Standardization (CEN) National Members, CEN/ TC19 Secretariat (astm@nen.nl.) Web site www.cen.eu.

3 Terms and definitions

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

3.1

biodiesel

mono-alkyl esters of long-chain fatty acids derived from renewable sources. In its neat form, biodiesel is commonly designated as B100. In the context of this standard the biodiesel is intended as a blending component in a finished diesel fuel or heating oil.

3.2

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 classical compression-ignition engines.

3.3

heating fuel oil

distillate fuel oil intended for use in liquid-fuel-burning equipment for the generation of heat for domestic and industrial purposes.

3.4

middle distillate fuel

fuel boiling in the range of 130–400°C composed of hydrocarbons, including naturally occurring, petroleum-derived, non-hydrocarbons.

4 General requirements

4.1 The biodiesel specified shall be long chain alkyl esters and may contain additives designed to improve its properties or performance, for example, diesel ignition quality, low-temperature flow properties and electrical conductivity.

4.2 The biodiesel shall be a stable homogeneous liquid free from foreign matter that is likely to clog filters or nozzles, or to damage equipment. Haze may be assessed using CAN/CGSB-3.0 No. 28.8 or ASTM D4176, Procedure 2.

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 biodiesel.

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. The biodiesel meeting this standard may contain up to 0.5% by volume middle distillate. Metered volumes shall be reported.

5.2 Specified limiting values

5.2.1 The biodiesel 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.

5.2.2 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 5.5 and 5.23).

5.2.3 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.

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

5.3 Test methods

5.3.1 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.

5.3.2 Differences in precision, sensitivity and bias between test methods referenced in the standard and the validated test methods shall be noted.

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

5.3.4 In the event of a dispute, the procedures given in 5.2 shall be used.

5.3.5 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.

		Specified limiting values			
	Property	Min.	Max.	Test method	
5.4	Kinematic viscosity at 40°C, mm²/s (cSt) a	1.9	6.0	ASTM D445° or ASTM D7042	
5.5	Flash point, °C (see 5.23)	93.0	_	ASTM D93°, ASTM D7094 or ASTM D3828	

		Specified limiting values			
	Property	Min.	Max.	Test method	
5.6	Methanol content; either a) % by mass (see 5.24)	_	0.20	EN 14110	
	b) Flash point, °C (see 5.23 and 5.24)	130.0	—	ASTM D93°, ASTM D7094, or ASTM D3828	
5.7	Cloud point °C, (see. 5.25)	Report		ASTM D5771, ASTM D5772, ASTM D7397, ASTM D2500, or ASTM D5773°	
5.8	Sulphur, mg/kg (ppm mass) (see. 5.26)	Report		ASTM D2622, ASTM D5453 ^b or ASTM D7039	
5.9	Density, kg/m ³	Report		ASTM D1298°, or ASTM D4052	
5.10	Carbon residue, % by mass (see 5.27)	_	0.05	ASTM D524 or ASTM D4530°	
5.11	Water content, mg/kg (ppm mass)		400.	ASTM D6304	
5.12	Particulate contamination, mg/L		20.	ASTM D7321	
5.13	Acid number, mg KOH/g	-	0.50	ASTM D664	
5.14	Oxidation stability, h	8	_	EN 14112 or EN 15751°	
5.15	Free glycerin, % by mass	—	0.020	ASTM D6584	
5.16	Total glycerin, % by mass	—	0.240	ASTM D6584	
5.17	Phosphorus content, mg/kg (ppm mass)	—	4	EN 14107	
5.18	Alkaline I metals, Na + K, mg/kg (ppm mass)	_	4	EN 14538	
5.19	Alkaline II metals, Ca + Mg, mg/kg (ppm mass)	-	2	EN 14538	
5.20	Cold soak filterability test, s		240.	ASTM D7501	
5.21	Cold soak filter blocking tendency, no.	-	1.8	CAN/CGSB-3.0 No. 142.0	
5.22	Ignition quality, cetane number (see 7.1 b)	Report If required		ASTM D613°, ASTM D6890, ASTM D7170, or ASTM D7668	
	^a The SI unit for kinematic viscosity is the squ viscosity range is the square millimetre per set	¹ ¹ ¹ ¹ ³ The SI unit for kinematic viscosity is the square metre per second. The preferred multiple for fluids in t viscosity range is the square millimetre per second, which is equivalent to centiStokes (i.e. 1 mm ² /s = 1 cSt).			

^b Referee method to be used in the event of a dispute.

5.23 Flash point

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

5.24 Methanol content

Methanol content is controlled either by direct measurement of methanol or by a minimum flash point. See Annex C, C3.2.

5.25 Cloud point

Cloud point may be specified (see 7.1) as required by the conditions of storage or use or as agreed by contract.

5.26 Sulphur

See Annex B for regulations regarding sulphur in diesel fuel.

5.27 Carbon residue

Testing shall be performed on the neat biodiesel sample and not on a 10% distillation bottoms.

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 and 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 7.1), a sample of at least 3 L shall be collected.

7 Options

7.1 Limiting values

Limiting values for the following may be specified (see Annex C, C1.3):

- a) Sulphur
- b) Cetane number
- c) Cloud point
- d) Sample size (see. 6.1.2).

8 Precautions

8.1 Alternate B100 standards or specifications

This standard is intended to address performance requirements for Canada. Other international standards or specifications may not take into consideration Canadian conditions such as the cold climate.

8.2 Manufacturing processes

Contaminants and trace components from manufacturing processes or treatments can be carried over in trace quantities into the biodiesel and can cause unexpected problems. Moreover, these materials 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 any manufacturing processes capable of such contamination are identified and controlled. Clay, sand, acids, caustic, soaps, sterol glucosides, saturated monoglycerides and other potential precipitates are examples of possible contaminants and trace minerals.

8.3 Material Incompatibility of biodiesel

Biodiesels are incompatible with some elastomeric materials, and they can lead to corrosion of some non-ferrous metals particularly when free water is present. The degradation products that are formed can cause operational issues.

8.4 Impact of free water on storage and handling of biodiesel

In the presence of free water, biodiesel can be more vulnerable to degradation than conventional petroleum-derived diesel fuel. See Annex C, Section C17 for guidance on storage and handling, and ASTM D6469 for information on microbial contamination.

Annex A

(normative)

Referenced ASTM International publications (see 2.2)

Annual Book of ASTM Standards

- D93 Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester D445 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity) 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 D1298 Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method D2500 Standard Test Method for Cloud Point of Petroleum Products D2622 Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry 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 D4052 Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter 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) 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

- D6304 Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
- D6469 Standard Guide for Microbial Contamination in Fuels and Fuel Systems
- D6584 Standard Test Method for Determination of Total Monoglyceride, Total Diglyceride, Total Triglyceride, and Free and Total Glycerin in B-100 Biodiesel Methyl Esters by Gas Chromatography
- 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
- 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
- D7321 Standard Test Method for Test Method for Particulate Contamination of Biodiesel B100 Blend Stock Biodiesel Esters and Biodiesel Blends by Laboratory Filtration
- D7397 Standard Test Method for Cloud Point of Petroleum Products (Miniaturized Optical Method)
- D7501 Standard Test Method for Determination of Fuel Filter Blocking Potential of Biodiesel (B100) Blend Stock by Cold Soak Filtration Test (CSFT)
- 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
- 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^{1,2}

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 for use 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.

¹ 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.

² 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.

B.2 Provincial and territorial 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 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, 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.

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. 28,1375³. 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.

³ 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.

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 (Loi sur la santé et la sécurité du travail)* 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.

Annex C

(informative)

Significance of requirements for biodiesel B100

C.1 Introduction

C.1.1 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 is then removed from the biodiesel fuel component.

C.1.2 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.1.3 The application of the options listed in 7.1 should be based upon information on the following parameters:

- a) Intended usage
- b) Storage conditions
- c) Sulphur limits
- d) Cloud point limits
- e) Legal requirements.

C.2 Flash point

C.2.1 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 (TDG) Regulations*, and safety precautions involved in fuel handling and storage. It is normally specified to meet insurance and fire regulations.

C.2.2 The flash point of biodiesel is higher than for diesel fuels. However, the actual flash point of a biodiesel can be related to the concentration of alcohol remaining after its production. This standard (CAN/CGSB-3.524) allows the use of flash point to limit the remaining alcohol in the biodiesel. The flash point specification, when used for alcohol control for biodiesel, is intended to be 130.0°C minimum, which has been correlated to 0.2% alcohol by volume in studies.

C.3 Viscosity and lubricity

C.3.1 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 filters or screens).

C.3.2 While a biodiesel complying with this standard can have a viscosity up to 6.0 cSt at 40°C, current fuel specifications limit the maximum viscosity of Type B diesel fuel to 4.1 cSt and Type 2 heating fuel oils to 3.6 cSt. These maximum viscosity limits could restrict the amount of biodiesel used in some blended fuels.

C.4 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.5 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.6 Low-temperature operability

C.6.1 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.6.2 The low temperature operability of biodiesel can be a limiting factor in some applications. Biodiesel components typically have relatively high cloud points (-5 to +15°C), depending upon the source of the feedstock.

C.6.3 The specified CSFBT (see C.12) limiting value is intended to ensure acceptable operability performance of blends of biodiesel with diesel fuels above the cloud point of the resulting blend. The CSFBT is complementary to ASTM D7501 — *Standard Test Method for Determination of Fuel Filter Blocking Potential of Biodiesel (B100) Blend Stock by Cold Soak Filtration Test (CSFT)*. The CSFBT can detect trace constituents of low solubility that are not detected by ASTM D7501.

C.7 Ash

C.7.1 Ash-forming material 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.8 Acidity

Biodiesel, as manufactured, typically has a higher acid number than diesel fuel. This is due to the presence of longchain 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.9 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.10 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 feedstock type or manufacturing processes. Fuel in long-term storage can darken, due to oxidation. If the darkening is accompanied by the formation of sediment, the fuel could be rendered unacceptable for use. Fuels having unusual shades of colour should be investigated to determine fitness for use.

C.11 Oxidation stability

Products of oxidation in biodiesel can take the form of various acids or polymers, which, if in high enough concentration, can cause fuel system deposits and lead to filter clogging and fuel system malfunctions. Additives designed to retard the formation of acids and polymers can significantly improve the oxidation stability performance of biodiesel. See Annex C, C.17 for additional information on long-term storage.

C.12 Free glycerin

High levels of free glycerin can cause deposits in diesel fuel injection equipment such as injectors and fuel pumps. Free glycerin can also build up in the bottom of storage tanks.

C.13 Total glycerin

Total glycerin includes free glycerin and the glycerin portion of any unreacted or partially reacted oil or fat. Low levels of total glycerin ensure that high conversion of the oil or fat into its mono-alkyl esters has taken place. High levels of mono-, di-, and triglycerides can cause injector deposits, can adversely affect cold weather operation and can plug filters.

C.14 Phosphorus

Phosphorus can poison or deactivate catalysts used in exhaust after-treatment systems so its level must be kept low.

C.15 Cold soak filtration test (CSFT)

The CSFT test method determines by filtration time after a cold soak, the suitability of a biodiesel (B100) to provide adequate low-temperature operability performance to at least the cloud point of the finished blend provided it meets all other requirements of this standard and has a cloud point below 20°C.

C.16 Cold soak filter blocking tendency (CSFBT)

Minor components of some biodiesel, including saturated monoglycerides, can separate above the cloud point of a biodiesel fuel blend. The CSFBT test quantifies the propensity of these materials to separate from a biodiesel, diluted with isoparaffinic solvent, after a cold soak cycle.

C.17 Ignition quality: Cetane number and derived cetane number

C.17.1 Cetane number as determined by 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.17.2 Test methods ASTM D6890, D7170 and D7668, which give a derived cetane number, are applicable to biodiesel fuel blends.

C.18 Calcium, magnesium, sodium and potassium

Calcium, magnesium, sodium and potassium can be present in biodiesel as abrasive solids or soluble metallic soaps. Abrasive solids can contribute to injector, fuel pump, piston, and ring wear, as well as to engine deposits. Soluble metallic soaps have little effect on wear, but they can contribute to filter plugging and engine deposits. The elements can form ash compounds that can also accumulate in diesel particulate filters and their removal requires special maintenance procedures. High levels of these ash compounds in the fuel can lead to increased engine backpressure and more frequent service intervals.

C.19 Storage and handling

C.19.1 Guidance on practices for storage, handling and blending of biodiesel is available at the following references.

C.19.1.1 Guidelines for handling and blending FAME, CONCAWE Report 9/09, available as a PDF at www.concawe.org.

C.19.1.2 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.