

English Version

Automotive fuels - Diesel - Requirements and test methods

Carburants pour automobiles - Carburants pour moteur
diesel (gazole) - Exigences et méthodes d'essai

Kraftstoffe für Kraftfahrzeuge - Dieseldieselkraftstoff -
Anforderungen und Prüfverfahren

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Foreword

This document (EN 590:2009) has been prepared by Technical Committee CEN/TC 19 "Gaseous and liquid fuels, lubricants and related products of petroleum, synthetic and biological origin", the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2009, and conflicting national standards shall be withdrawn at the latest by October 2009.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 590:2004.

This document has been prepared as part of a mandate given to CEN by the European Commission and the European Free Trade Association. It stipulates the first step towards fulfilling that mandate, i.e. to reflect the different characteristics of FAME blended up to 10 % (V/V) in diesel compared to pure hydrocarbon diesel.

The requirements of the European Fuels Directive 98/70/EC [1], including amendment 2003/17/EC [2] have been included. Table 1 explicitly differentiates between requirements included in the European Fuels Directive 98/70/EC [1], including Amendment 2003/17/EC [2], and other requirements. Dates are included with all normative test method references in order to comply with the requirements of the European Commission, with the accompanying assurance that updated versions will always give similar accuracy and the same or better precision.

Significant technical changes between this European Standard and the previous edition are:

- a) Provision is made for a maximum of 7 % (V/V) of fatty acid methyl esters (FAME) to be included in automotive diesel fuel.
- b) Inclusion of the revised EN 14214 FAME specification.
- c) Clarification of the fact that cold flow requirements of FAME when used as an extender for diesel according to this specification (as set out in Table 2 of EN 14214:2008) do not apply.
- d) Addition of the Ignition Quality Tester as an alternate test method to the CFR engine test.
- e) Deletion of the 350 mg/kg sulfur content, which was only allowed until 2005.
- f) Inclusion of the revised total contamination test method EN 12662, which in itself is again under revision to improve precision for FAME containing product following new interlaboratory studies.
- g) Inclusion of the revised EN 12916, which is now able to distinguish between polycyclic aromatic hydrocarbons and fatty acid methyl esters (FAME) due to the deletion of the back-flush step.
- h) Inclusion of an additional requirement and method (EN 15751) to determine the oxidation stability, with a limit of 20h.
- i) Addition of a workmanship clause 5.4.3 and a note referring to good house keeping via CEN/TR 15367-1.
- j) A general update of the revised test methods, some of them already having been included in the Technical Corrigendum to the previous version.

Annex A is normative and contains the precision data generated on the test methods which are the result of inter-laboratory testing, carried out by working groups of CEN/TC 19. Many of the test methods included in this standard were the subject of inter-laboratory testing to determine the applicability of the method and its precision in relation to blends of automotive diesel fuel containing 5 % (V/V) or higher of different sources of fatty acid methyl esters (FAME), a.o. rape seed and sunflower oil.

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According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies requirements and test methods for marketed and delivered automotive diesel fuel. It is applicable to automotive diesel fuel for use in diesel engine vehicles designed to run on automotive diesel fuel.

NOTE For the purposes of this European Standard, the terms “% (m/m)” and “% (V/V)” are used to represent respectively the mass fraction and the volume fraction.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 116:1997, *Diesel and domestic heating fuels - Determination of cold filter plugging point*

EN 12662:2008, *Liquid petroleum products – Determination of contamination in middle distillates*

EN 12916:2006, *Petroleum products – Determination of aromatic hydrocarbon types in middle distillates – High performance liquid chromatography method with refractive index detection*

EN 14078:2003, *Liquid petroleum products – Determination of fatty acid methyl esters (FAME) in middle distillates – Infrared spectroscopy method*

EN 14214:2008, *Automotive fuels – Fatty acid methyl esters (FAME) for diesel engines – Requirements and test methods*

EN 15195:2007, *Liquid petroleum products — Determination of ignition delay and derived cetane number (DCN) of middle distillate fuels by combustion in a constant volume chamber*

EN 15751:2009, *Automotive fuels — Fatty acid methyl ester (FAME) fuel and blends with diesel fuel — Determination of oxidation stability by accelerated oxidation method*

EN 23015:1994, *Petroleum products - Determination of cloud point (ISO 3015:1992)*

EN ISO 2160:1998, *Petroleum products - Corrosiveness to copper - Copper strip test (ISO 2160:1998)*

EN ISO 2719:2002, *Determination of flash point - Pensky-Martens closed cup method (ISO 2719:2002)*

EN ISO 3104:1996, *Petroleum products - Transparent and opaque liquids - Determination of kinematic viscosity and calculation of dynamic viscosity (ISO 3104:1994)*

EN ISO 3170:2004, *Petroleum liquids – Manual sampling (ISO 3170:2004)*

EN ISO 3171:1999, *Petroleum liquids – Automatic pipeline sampling (ISO 3171:1988)*

EN ISO 3405:2000, *Petroleum products - Determination of distillation characteristics at atmospheric pressure (ISO 3405:2000)*

EN ISO 3675:1998, *Crude petroleum and liquid petroleum products - Laboratory determination of density - Hydrometer method (ISO 3675:1998)*

EN ISO 4259:2006, *Petroleum products - Determination and application of precision data in relation to methods of test (ISO 4259:2006)*

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EN ISO 4264:2007, *Petroleum products - Calculation of cetane index of middle-distillate fuels by the four-variable equation (ISO 4264:2007)*

EN ISO 5165:1998, *Petroleum products – Determination of the ignition quality of diesel fuels – Cetane engine method (ISO 5165:1998)*

EN ISO 6245:2002, *Petroleum products - Determination of ash (ISO 6245:2001)*

EN ISO 10370:1995, *Petroleum products - Determination of carbon residue - Micro method (ISO 10370:1993)*

EN ISO 12156-1:2006, *Diesel fuel - Assessment of lubricity using the high-frequency reciprocating rig (HFRR) – Part 1: Test method (ISO 12156-1:2006)*

EN ISO 12185:1996, *Crude petroleum and petroleum products - Determination of density - Oscillating U-tube method (ISO 12185:1996)*

EN ISO 12205:1996, *Petroleum products - Determination of the oxidation stability of middle-distillate fuels (ISO 12205:1995)*

EN ISO 12937:2000, *Petroleum products - Determination of water - Coulometric Karl Fischer titration method (ISO 12937:2000)*

EN ISO 13759:1996, *Petroleum products - Determination of alkyl nitrate in diesel fuels - Spectrometric method (ISO 13759:1996)*

EN ISO 20846:2004, *Petroleum products – Determination of sulfur content of automotive fuels – Ultraviolet fluorescence method (ISO 20846:2004)*

EN ISO 20847:2004, *Petroleum products – Determination of sulfur content of automotive fuels – Energy-dispersive X-ray fluorescence spectrometry (ISO 20847:2004)*

EN ISO 20884:2004 *Petroleum products – Determination of sulfur content of automotive fuels – Wavelength-dispersive X-ray fluorescence spectrometry (ISO 20884:2004)*

3 Sampling

Samples shall be taken as described in EN ISO 3170 or EN ISO 3171 and/or in accordance with the requirements of national standards or regulations for the sampling of automotive diesel fuel. The national requirements shall be set out in detail or shall be referred to by reference in a National Annex to this European Standard.

In view of the sensitivity of some of the test methods referred to in this European Standard, particular attention shall be paid to compliance with any guidance on sampling containers which is included in the test method standard.

4 Pump marking

Information to be marked on dispensing pumps used for delivering automotive diesel fuel, and the dimensions of the mark shall be in accordance with the requirements of national standards or regulations for the marking of pumps for automotive diesel fuel. Such requirements shall be set out in detail or shall be referred to by reference in a National Annex to this European Standard.

NOTE It is recommended to set marking for sulfur in a National Annex to this European Standard. The recommended designation for maximum 10 mg/kg sulfur content is “sulfur-free” in national language.

5 Requirements and test methods

5.1 Dyes and markers

The use of dyes or markers is allowed.

5.2 Additives

In order to improve the performance quality, the use of additives is allowed. Suitable fuel additives without known harmful side-effects are recommended in the appropriate amount, to help to avoid deterioration of driveability and emissions control durability. Other technical means with equivalent effect may also be used.

NOTE Deposit forming tendency test methods suitable for routine control purposes have not yet been identified and developed.

5.3 Fatty acid methyl ester (FAME)

Diesel fuel may contain up to 7 % (V/V) of FAME complying with EN 14214, in which case the climate-dependent requirements set out in 5.4 of EN 14214:2008 do not apply. The finished blend of diesel fuel shall however comply with the climate dependent requirements set out in 5.5.

It is strongly recommended to add oxidation stability enhancing additives in the FAME product, at the production stage and before storage, providing an action similar to that obtained with 1 000 mg/kg of 3,5-di-tert-butyl-4-hydroxy-toluol (butylated hydroxyl-toluene, BHT).

NOTE 1 A suitable method for the separation and identification of FAME is given in EN 14331 [3].

NOTE 2 Requiring FAME to meet the climate-dependent requirements set out in EN 14214 could result in incompatibility between the cold flow additives used in the FAME and the diesel fuel. This may compromise the performance of the finished diesel/FAME blend in respect of the low temperature operability and cause field failures as result of filter plugging in cold weather. Cold flow additives should be specifically matched to the base diesel fuel and FAME quality to ensure correct performance consistent with the requirements set out in this European Standard. The choice of cold flow additive technology should be a contractual matter between the fuel blender and the biodiesel supplier taking into account the climatic-dependent requirements of the finished diesel fuel.

5.4 Generally applicable requirements and related test methods

5.4.1 When tested by the methods indicated in Table 1, automotive diesel fuel shall be in accordance with the limits specified in Table 1. The test methods listed in Table 1 have been assessed for application to automotive diesel containing up to 7 % (V/V) FAME. Precision data from interlaboratory test programmes are given in normative Annex A, where these were found to be different from the precision data given in the test methods for neat petroleum products.

5.4.2 The limiting value for the carbon residue given in Table 1 is based on product prior to addition of ignition improver, if used. If a value exceeding the limit is obtained on finished fuel in the market, EN ISO 13759 shall be used as an indicator of the presence of a nitrate-containing compound. If an ignition improver is thus proved present, the limit value for the carbon residue of the product under test cannot be applied. The use of additives does not exempt the manufacturer from meeting the requirement of maximum 0,30 % (m/m) of carbon residue prior to addition of additives.

5.4.3 Diesel fuel shall be free from any adulterant or contaminant that may render the fuel unacceptable for use in diesel engine vehicles

NOTE For further information on preventing contamination by water or sediment that may occur in the supply chain, or for cross-contamination, it is advisable to check CEN/TR 15367-1 [4] or -3 [5] respectively..

Table 1 - Generally applicable requirements and test methods

Property	Unit	Limits		Test method ^a (See 2. Normative references)
		minimum	maximum	
Cetane number^b		51,0	–	EN ISO 5165 EN 15195
Cetane index		46,0	–	EN ISO 4264
Density at 15 °C^c	kg/m³	820,0	845,0	EN ISO 3675 EN ISO 12185
Polycyclic aromatic hydrocarbons^d	% (m/m)	–	11	EN 12916
Sulfur content^e	mg/kg	–	50,0 until 2008-12-31	EN ISO 20846 EN ISO 20847 EN ISO 20884
			10,0	EN ISO 20846 EN ISO 20884
Flash point	°C	Above 55	–	EN ISO 2719
Carbon residue ^f (on 10 % distillation residue)	% (m/m)	–	0,30	EN ISO 10370
Ash content	% (m/m)	–	0,01	EN ISO 6245
Water content	mg/kg	–	200	EN ISO 12937
Total contamination	mg/kg	–	24	EN 12662 ^g
Copper strip corrosion (3 h at 50 °C)	rating	class 1		EN ISO 2160
Fatty acid methyl ester (FAME) content^h	% (V/V)	-	7,0	EN 14078
Oxidation stability	g/m ³	–	25	EN ISO 12205
	h	20	-	EN 15751 ⁱ
Lubricity, corrected wear scar diameter (wsd 1,4) at 60 °C	µm	–	460	EN ISO 12156-1
Viscosity at 40 °C	mm ² /s	2,00	4,50	EN ISO 3104
Distillation^{k,l}				EN ISO 3405
% (V/V) recovered at 250 °C	% (V/V)		< 65	
% (V/V) recovered at 350 °C	% (V/V)	85		
95 % (V/V) recovered at	°C		360	

NOTE Requirements in bold refer to the European Fuels Directive 98/70/EC [1], including Amendment 2003/17/EC [2]

^a See also 5.6.1

^b See also 5.6.4

^c See also 5.6.2

^d For the purposes of this European Standard, polycyclic aromatic hydrocarbons are defined as the total aromatic hydrocarbon content less the mono-aromatic hydrocarbon content, both as determined by EN 12916.

^e See also 5.6.3

^f See also 5.4.2 and Annex A

^g Further investigation into the total contamination test method to improve the precision, particularly in the presence of FAME, is being carried out by CEN

^h FAME shall meet the requirements of EN 14214

ⁱ For diesel fuel containing FAME above 2 % (V/V) this is an additional requirement. This is an interim requirement, under revision by CEN, when more technical data on oxidation stability and field performance of diesel fuels will be available.

^k For the calculation of the cetane index the 10 %, 50 % and 90 % (V/V) recovery points are also needed.

^l The limits for distillation at 250 °C and 350 °C are included for diesel fuel in line with EU Common Customs tariff.

5.5 Climate dependent requirements and related test methods

5.5.1 For climate-dependent requirements options are given to allow for seasonal grades to be set nationally. The options are for temperate climates six CFPP (cold filter plugging point) grades and for arctic or severe winter climates five different classes. Climate-dependent requirements are given in Table 2 (temperate climates) and Table 3 (arctic or severe winter climates). When tested by the methods given in Tables 2 and 3, automotive diesel fuel shall be in accordance with the limits specified in these Tables.

5.5.2 The cetane number limits for arctic or severe winter grades in Table 3 are lower than for the temperate class (Table 1), reflecting the correlation between ignition quality and density, and the low density of arctic or severe winter grades. The values for cetane number given in Table 3, included for correct vehicle operation, do not meet the requirements of the European Fuels Directive 98/70/EC [1], including Amendment 2003/17/EC [2]. These values are valid for use in countries where the European Fuels Directive 98/70/EC [1], including Amendment 2003/17/EC [2], does not apply or for countries where cetane number exceptions have been granted for arctic or severe winter grades.

Table 2 - Climate-related requirements and test methods - Temperate climates

Property	Unit	Limits						Test method ^a (See 2. Normative references)
		Grade A	Grade B	Grade C	Grade D	Grade E	Grade F	
CFPP	°C, max.	+5	0	-5	-10	-15	-20	EN 116

^a See also 5.6.1

Table 3 - Climate-related requirements and test methods - Arctic or severe winter climates

Property	Units	Limits					Test method ^a (See 2. Normative references)
		class 0	class 1	class 2	class 3	class 4	
CFPP	°C, max.	-20	-26	-32	-38	-44	EN 116
Cloud point	°C, max.	-10	-16	-22	-28	-34	EN 23015
Density at 15 °C ^b	kg/m ³ , min. kg/m ³ , max.	800,0 845,0	800,0 845,0	800,0 840,0	800,0 840,0	800,0 840,0	EN ISO 3675 EN ISO 12185
Viscosity at 40 °C	mm ² /s, min. mm ² /s, max.	1,50 4,00	1,50 4,00	1,50 4,00	1,40 4,00	1,20 4,00	EN ISO 3104
Cetane number ^c	minimum	49,0	49,0	48,0	47,0	47,0	EN ISO 5165 EN 15195
Cetane index	minimum	46,0	46,0	46,0	43,0	43,0	EN ISO 4264
Distillation ^{d,e}							EN ISO 3405
% (V/V) recovered at 180 °C	% (V/V), max.	10	10	10	10	10	
% (V/V) recovered at 340 °C	% (V/V), min.	95	95	95	95	95	

^a See also 5.6.1
^b See also 5.6.2
^c See also 5.5.2 and 5.6.4
^d EU Common Customs Tariff definition of gas oil may not apply to the grades defined for use in arctic or severe winter climates.
^e For the calculation of the cetane index the 10 %, 50 % and 90 % (V/V) recovery points are also needed

5.5.3 In a National Annex to this European Standard, each country shall detail requirements for a summer and a winter grade and may include (an) intermediate and/or regional grade(s) which shall be justified by national meteorological data.

5.6 Precision and dispute

5.6.1 All test methods referred to in this European Standard include a precision statement. In cases of dispute, the procedures for resolving the dispute and interpretation of the results based on test method precision, described in EN ISO 4259, shall be used.

5.6.2 In cases of dispute concerning density, EN ISO 3675 shall be used.

5.6.3 In cases of dispute concerning sulfur content, EN ISO 20847 is unsuitable as an arbitration method.

5.6.4 In cases of dispute concerning cetane number, EN ISO 5165 shall be used. For the determination of cetane number alternative methods to those indicated in Table 1 and Table 3 may also be used, provided that these methods originate from a recognized method series, and have a valid precision statement, derived in accordance with EN ISO 4259, which demonstrates precision at least equal to that of the referenced method. The test result, when using an alternative method, shall also have a demonstrable relationship to the result obtained when using the referenced method.

Annex A (Normative)

Details of inter-laboratory test programme

Table A.1 presents the precision data obtained in inter-laboratory testing programmes by CEN/TC 19 [6] and the EI [7], that differ from those of test methods listed in Table 1 and that at the time of publication of this European Standard were not yet revised.

NOTE The following methods were found to have precision data for 5 % (V/V) FAME blends similar to the published values:

Ash content EN ISO 6245
Oxidation stability EN ISO 12205
Distillation EN ISO 3405
CFPP EN 116

Table A.1 - Precision data updates

Property	Test method	Unit	CEN/TC 19 data for 5 % (V/V) FAME blend
Viscosity at 40 °C	EN ISO 3104	mm ² /s	r = 0,11 % R = 1,8 %
Flash point	EN ISO 2719	°C	r = 2,0 R = 3,5
Carbon residue	EN ISO 10370	% (m/m)	r = 0,143 0 X ^{0,5} R = 0,212 5 X ^{0,5}
where: r is repeatability (EN ISO 4259) R is reproducibility (EN ISO 4259) X is the mean of two results being compared			

Bibliography

- [1] *Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC*
- [2] *Directive 2003/17/EC of the European Parliament and of the Council of 3 March 2003 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC*
- [3] EN 14331:2004, *Liquid petroleum products – Separation and characterization of fatty acid methyl esters (FAME) from middle distillates – Liquid chromatography (LC)/ gas chromatography (GC) method*
- [4] CEN/TR 15367-1, *Petroleum products - Guide for good housekeeping – Part 1. Automotive diesel fuels*
- [5] CEN/TR 15367-3, *Petroleum products - Guide for good housekeeping – Part 3. Cross contamination*
- [6] CEN/TR 15160, *Petroleum and related products — Applicability of diesel fuel test methods for Fatty Acid Methyl Esters (FAME) — Information and results on round robin tests*
- [7] EI Research Report on IP 398 and EN ISO 10370, under publication, available from the Energy Institute, 61 New Cavendish Street, London W1G 7AR, England