



Technical Circular

0199-99-01218/4 EN

This Circular supersedes: 0199-99-01218/3

Date: 17.11.2017

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DEUTZ engines

- All DEUTZ engines



Fuels

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General

This bulletin defines for which compact engines of the DEUTZ brand the following fuels are approved:

- Diesel fuels
- Non-road fuels and light heating oils
- Synthetic and paraffinic fuels (HVO, GtL, CtL, BtL)
- Biofuels (biodiesel and vegetable oils)
- Jet fuels
- Marine distillate fuels (MDF)

For general data on fuels, see section:

- Biological contamination in fuels
- Fuel additives
- Fuel filter
- General information on fuel properties



This Technical Bulletin applies for all air-cooled and liquid-cooled compact engines of the DEUTZ brand. For engines which are no longer in production, this TR applies accordingly. This bulletin only applies up to year of production 2000 for engines of the 226 series.

Fuels must be used as regulated in the respective national regulations (e.g. in Germany in the 10th BImSchV). No fuels which deviate from these national regulations may be used (e.g. no fuel may be used in Europe if it only meets the limit values of the US standard purely by chance).

The certification measurements for compliance with the legal emission limit values are carried out with the test fuels specified in the laws. These correspond to the diesel fuels according to EN 590 and ASTM D975 described in the following section. With the other fuels described in this bulletin, no emission values are guaranteed. The operator is obliged to check the permission for the use of fuels according to the national regulations.

Engines fitted with an exhaust gas after-treatment system such as a closed diesel particle filter (DPF), diesel oxidation catalytic converter (DOC) or selective catalytic reduction system (SCR) may only be operated with sulphur-free diesel fuels. Otherwise compliance with the emission requirements and durability is not guaranteed.

In a warranty case, the customer must prove that a released fuel was used by providing a certificate from the fuel supplier.

The following list specifies the released fuels for the different series and emission stages, the following text contains further data about these releases:

List of released fuels

	413 513 912 913 914	1008 2008 2009 226 909 910	1011 2011	1012 1013 2012 2013	1015	413 513 912 913 914M 1013M 1015M 2015M Marine engines
	up to Tier 3 Stage IIIA	up to Tier 3 Stage IIIA	up to Tier 3 Stage IIIA	up to Tier 2 Stage II EURO 3	up to Tier 2 Stage II	
Diesel fuels in accordance with EN 590, ASTM D975 or JIS K 2204 ⁶	X	X	X	X	X	X
Non-road fuels (light heating oils) in accordance with DIN 51603	X	X	X	X	X	X
Biodiesel up to 100% EN14214, up to 20% ASTM D7467, biodiesel worldwide according to Appendix 14	X	–	X	X	–	X ⁴
Jet fuels	X	–	X	X	X ⁵	–
Marine distillate fuels (MDF) in accordance with ISO 8217	X	–	–	–	–	X
Diesel fuel world-wide according to appendix 5	X	X	X	X	X	X
Paraffinic diesel fuel (GtL, HVO)	X ⁹	–	X ¹⁰	X	X	X ⁹

	TCD 2012 2V 2012 4V	TCD 2013 2V 2013 4V	TCD 2013 4V Com- mercial vehicles up to Euro III	TCD 2013 4V Com- mercial vehicles Euro IV Euro V	TCD 2015 Tier 3 Stage IIIA Euro III	DEUTZ Natural Fuel Engine [®] Stage IIIA
Diesel fuels in accordance with EN 590, ASTM D975 or JIS K 2204 ⁶	X	X	X	X	X ⁸	X
Non-road fuels (light heating oils) in accordance with DIN 51603	X	X	–	–	X	X ¹
Biodiesel up to 100% EN14214, up to 20% ASTM D7467, biodiesel worldwide according to Appendix 14	X	X	X	X	X ²	X
Vegetable oil (DIN 51605)	–	–	–	–	–	X
Jet fuels	X ⁵	X ⁵	–	–	X ⁵	–



	TCD 2012 2V 2012 4V	TCD 2013 2V 2013 4V	TCD 2013 4V Com- mercial vehicles up to Euro III	TCD 2013 4V Com- mercial vehicles	TCD 2015	DEUTZ Natural Fuel Engine®
	Tier 3 Stage IIIA	Tier 3 Stage IIIA	Euro III	Euro IV Euro V	Tier 3 Stage IIIA Euro III	Stage IIIA
Marine distillate fuels (MDF) in accordance with ISO 8217	–	–	–	–	–	–
Diesel fuel world-wide according to appendix 5	X	X	X	–	X	–
Paraffinic diesel fuel (GtL, HVO)	X	X	X	X	X	–

	2.9 3.6 up to Tier 3	2.9 3.6 from Tier 4 interim Stage IIIB	4.1 6.1 7.8 up to Tier 3	4.1 6.1 7.8 from Tier 4 interim Stage IIIB	12.0 V6 16.0 V8 from Tier 4 interim Stage IIIB
Diesel fuels in accordance with EN 590, ASTM D975 or JIS K 2204 ⁶	X	X ³	X	X ³	X ³
Non-road fuels (light heating oils) in accordance with DIN 51603	–	X ¹	–	X ¹	X ¹
Biodiesel (up to 100 % EN14214, up to 20 % ASTM D7467)	–	X	–	X ¹¹	X
Jet fuels	–	–	–	–	–
Marine distillate fuels (MDF) in accordance with ISO 8217	–	–	–	–	–
Diesel fuel world-wide according to appendix 5	X ⁷	–	X ⁷	–	–
Paraffinic diesel fuel (GtL, HVO)	X	X ¹¹	X	X ¹¹	X

Restrictions	
X ¹	Release only for non-road heating oils with EN 590 quality, see chapter non-road fuels and light heating oils.
X ²	Release for engines as of 01.07.2010, retrofitting possible in earlier engines. US biodiesel release up to 50% (V/V) for mine engines (MSHA)
X ³	Release for US diesel fuel in accordance with ASTM D975 S15 only
X ⁴	Does not apply for the 1015M series
X ⁵	Note special restrictions in the chapter "Jet fuels".
X ⁶	HFRR maximum 460 µm
X ⁷	Sulphur content maximum 500 mg/kg
X ⁸	Also applies for EURO 3
X ⁹	Does not apply for the 413, 513 series



Restrictions	
X ¹⁰	Does not apply for the 1011 series
X ¹¹	Does not apply for engines with active DPF regeneration (burner)

Diesel fuels

DEUTZ vehicle engines are designed for diesel fuels with a cetane number of at least 51. DEUTZ engines for mobile work machinery are designed for a cetane number of at least 45. When using fuels with a low cetane number, a disturbing formation of white smoke and ignition stutter is to be expected under some circumstances.

A cetane number of at least 40 is approved for the US market, which is why special engine versions were developed to avoid starting difficulties, extreme white smoke or increased hydrocarbon emissions. If the use of fuels with a very low cetane number is also known in advance in other countries, we recommend ordering the engines in EPA versions. It is generally recommended to use fuels with a higher cetane number than the minimum requirement of 40 in winter.

Diesel fuels are released and can be used in accordance with the following specifications:

Fuel	Specifications
DIN EN 590	Biodiesel content max. 7 %(V/V) Appendix 2
ASTM D975 Grade 1-D S15	Biodiesel content max. 5 %(V/V) Appendix 3
ASTM D975 Grade 2-D S15	
JIS K 2204	Appendix 4
NATO F-54	on request

Japanese diesel fuels according to JIS K 2204 Grade 1 Fuel und Grade 2 Fuel are only released if the lubricating properties correspond with diesel fuel EN 590 (HFRR max. 460 micrometer according to EN ISO 12156-1).

The EN 590 standard has the status of a national standard in the countries of the EU, e.g. DIN EN 590. The NATO fuel F-54 is equivalent to diesel fuel in accordance with EN 590, but with max. 50 mg/kg sulphur.

Diesel fuels in other countries

The table in appendix 5 contains the requirements for diesel fuels for the countries in which none of the released fuels named in this bulletin exist.

For new customers it must be ensured that all the necessary basic conditions are satisfied and release by the Sales department is available before using these fuels.

Fuel	Specifications
For countries in which none of the named diesel fuels released by DEUTZ exist.	Appendix 5

Lubricating capacity for low-sulphur and sulphur-free fuels

Insufficient lubricity can lead to serious wear problems, especially in common rail injection systems. Too low a lubricity is particularly a problem in fuels with a low sulphur content (and in this respect sulphur contents ≤ 500 mg/kg can already be considered low). An adequate lubricity is guaranteed by the appropriate additives at the refinery in low-sulphur (≤ 50 mg/kg) or sulphur-free (≤ 10 mg/kg or ≤ 15 mg/kg) diesel fuels according to EN 590 and ASTM D975. In low-sulphur and sulphur-free diesel fuels which do not comply with this standard, the lubricity may have to be guaranteed by additives. The parameter for sufficient lubricity is a maximum wear spot of 460 μ m in the HFRR test (EN ISO 12156-1).

Biodiesel components from 1 %(V/V) ensure compliance with the limit values.



High sulphur content in the fuel

Fuels with a sulphur content > 0.5 %(m/m) (5,000 mg/kg) demand a shorter lubricating oil change interval.



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Fuels with a high sulphur content may not be used in engines with exhaust gas after-treatment (from Tier 4 interim / Stage IIIB / Euro 4). Fuels with a sulphur content > 1.0 %(m/m) are not permissible due to high corrosion and considerable shortening of the engine life. Low-ash / low SAPS engine lubricating oils (sulphate ash max. 1.0 %(m/m)) may only be used in engines without exhaust after-treatment systems if the sulphur content in the fuel does not exceed 50 mg/kg. However, low-ash lubricating oils may be used in engines without exhaust gas after-treatment systems up to sulphur contents of 500 mg/kg if the base number (TBN) is at least 9 mg KOH/g. A corresponding note regarding suitable lubricating oils is published in the DEUTZ lubricating oil release list.

Winter operation with diesel fuel

Special demands are placed on the cold behaviour (temperature limit value of the filtrability) for winter operation. Suitable fuels are available at fuel stations in winter.

Diesel fuels up to -44 °C are available for an arctic climate (e.g. EN 590, Class 4 or US-DK Grade 1-D).



Mixing with petrol is not permissible for safety and technical reasons (cavitation in the injection system).

Adding kerosene to diesel fuel to improve the low-temperature characteristics is not permissible for engines with exhaust gas after-treatment and externally cooled exhaust gas recirculation.

The addition of flow improvers to the diesel fuel is only allowed in exceptional cases. The choice of a suitable additive and the necessary dosing and mixing procedure must be discussed with the fuel supplier.

Non-road fuels and light heating oils

In some European countries, non-road fuels are defined with the same properties as heating oil but are taxed differently to diesel fuels. Systems which allow the use of heating oils and are subject to tax relief in Germany are described in the Energy Taxation Act (§3).



The user must in principle abide by the nationally applicable tax regulations concerning the use of heating oil. These are not part of this technical bulletin.

With regard to use in the engine (warranty rights), no differences are to be made between the appropriate non-road fuels and light heating oils.

- For all non-road engines that are operated in Europe outside of Germany, light heating oils or non-road fuels may only be used if they are comparable with the specification EN 590, e.g. in France GNR (Gazole non Routier) and in Great Britain non-road fuel as per BS 2869:2010.

The density of the fuel must be a maximum of 0.860 g/cm³.

- Only biodiesel-free fuels may be used for emergency power supply units in standby operation. DEUTZ therefore recommends the use of light heating oil in accordance with **DIN 51603-1 low sulphur** (for Germany), **ÖNORM C1109 sulphur-free** (for Austria) or **SNV 181160-2 low sulphur** (for Switzerland).

Fuel	Specifications
DIN 51603-1 low sulphur	Appendix 6

Synthetic and paraffinic fuels (GTL, CTL, BTL and HVO)

These fuels are generated from natural gas (Gas-to-Liquid), carbon (Coal-to-Liquid), biomass (Biomass-to-Liquid) or from vegetable oils (HVO, Hydrogenated or Hydrotreated Vegetable Oils) through catalytic hydrogenation using the Fischer-Tropsch process.



Another option is to produce paraffinic diesel as an E-fuel through the Power-to-Liquid (PtL) process. Oxygen and hydrogen are produced through electrolysis of water. In the next step, the hydrogen that is generated in this way then reacts with CO₂ from combustion processes to form a synthesis gas which, in turn, can be converted back to a liquid fuel by means of the synthesis.

The provision of E-diesel using renewable power will ensure a more environmentally-friendly and CO₂-neutral engine operation.

These fuels are specified in the following standard:

Fuel	Specifications
EN 15940 (Automotive fuels - Paraffinic diesel fuel from synthesis or hydrotreatment)	Appendix 7

They fulfil the American diesel fuel standard ASTM D975 and, apart from the density, also the European diesel fuel standard EN 590.

They differ from diesel fuel as follows:

- Chemical composition
 - pure paraffin / ISO paraffin
 - no aromatics
 - no carbon double bonds
- High centane number
- Positive effects on
 - Emissions (nitric oxides and particles)
 - Engine acoustics
- Improved specific fuel consumption in g/kWh
- Lower density
 - resulting in a low, reduced engine performance

Currently, the following engine series are released in consideration of the following recommendations:

- Engines without exhaust gas after-treatment
 - 912/913/914/914M
 - 2011
 - 1012/2012/1013/1013M/2013
 - 1015/1015M/2015/2015M
 - TCD 2012 2V/4V
 - TCD 2013 2V/4V
- Engines with exhaust aftertreatment (DOC / DPF / SCR) of exhaust stages EU III B / EU IV or Tier 4i / Tier 4
 - D 2.9/TD 2.9/TCD 2.9
 - TD 3.6/TCD 3.6
 - TCD 4.1/TCD 6.1/TCD 7.8
 - TTCD 6.1/TTCD 7.8
 - TCD 12.0/TCD 16.0
- The following engines of exhaust stages EURO IV and V are also released:
 - TCD 2013 4V

Engines with exhaust gas after-treatment to actively regenerate (burner) exhaust stages EU IIIB / Tier 4i are not released.



It is a known fact that fuel leaks may occur in engines that were operated with standard diesel fuels for prolonged periods and then with paraffinic fuels. The reason for this behaviour is the altered swelling behaviour of NBR polymer seals in paraffinic diesel fuel compared to conventional diesel due to its freedom of aromatics.

The swelling problem does not arise if an engine is operated with paraffinic diesel fuel from the start or if FKM seals and polymer hoses are used.

Within the first four weeks of changing over to paraffinic diesel fuel, DEUTZ recommends checking the seals for leaks at regular intervals. If necessary, critical seals must be replaced.

The engine series from emission stages US EPA Tier 4 interim / EU Stage IIIB / EURO IV have resistant elastomers.

Because of their very positive influences with regard to the cetane number and emission behaviour, these paraffinic fuels are blended partly in the so-called premium diesel fuels and in this case have no negative influences on the polymer compatibility or the density. This addition is permissible within EN 590.

Biofuels

The generic term biofuels includes biodiesel and pure vegetable oils.

Biodiesel

Biodiesel is Fatty Acid Methyl Ester (FAME) of vegetable oils or animal fats. It is produced on a large scale by re-estering vegetable oils or fats with methanol to glycerine and fatty acid methyl ester. It is possible to use different vegetable oils such as soya oil, palm oil, rapeseed oil, sunflower oil or animal fats or used vegetable oils.

In Europe, biodiesel must comply with the EN 14214 standard. DEUTZ recommends that customers in Germany ensure the quality by buying biodiesel with an AGQM certificate (Arbeitsgemeinschaft Qualitätsmanagement Biodiesel e.V. (Association for Biodiesel Quality Management)).



A1: Biodiesel

Customers should also ensure that suppliers can confirm their compliance with quality requirements by showing a current analysis certificate. The analysis certificate should have been issued by a ISO 17025 certified laboratory or a laboratory certified by DIN-FAM and AGQM following a round-robin test for proving its measurement ability to determine key analytical figures.

The use of biodiesel for the US market is only permissible in mixtures with diesel fuel with a maximum biodiesel content of 20 % (V/V) in accordance with the ASTM D7467 standard. Users are recommended biodiesel qualities in accordance with BQ 9000.



Fuel	Specifications
Biodiesel according to EN 14214	Appendix 8
Biodiesel blends according to EN 16709 - High Fame Fuels (B20 and B30)	Appendix 9 Appendix 10
Biodiesel blend according to EN 16734 (B10)	Appendix 11
US biodiesel according to ASTM D6751 (B100) (only for biodiesel blends with diesel fuel > 20 %(V/V))	Appendix 12
US biodiesel blends according to ASTM D7467 (only for biodiesel blends with diesel fuel of 6-20 %(V/V))	Appendix 13

Biofuels in other countries

The table in appendix 14 contains the requirements for biofuels for the countries in which none of the released fuels named in this bulletin exist.

For new customers it must be ensured that all the necessary basic conditions are satisfied and release by the Sales department is available before using these fuels.

Fuel	Specifications
For countries in which none of the named biodiesel fuels released by DEUTZ exist.	Appendix 14

Released engines

Engines without exhaust gas after-treatment

up to emission stages US EPA Tier 3 / EU Stage IIIA / EURO III from year of production 1993*

Biodiesel according to EN 14214						
Biodiesel blends according to EN 16709 - High Fame Fuels (B20 and B30)						
Biodiesel blend according to EN 16734 (B10)						
US biodiesel according to ASTM D6751 (B100) (only for biodiesel blends with diesel fuel > 20 %(V/V)) only permitted for engines used in underground mining operation (MSHA: Mine Safety and Health Administration))						
US biodiesel blends according to ASTM D7467 (only for biodiesel blends with diesel fuel of 6-20 %(V/V))						
None of the named diesel fuels released by DEUTZ Minimum requirement according to appendix 14						
(1)	(2)	(3)	(4)	(5)	(6)	Series
x	x	x		x	x	413/513
x	x	x		x	x	912/913/914
x	x	x		x	x	1011/2011
x	x	x		x	x	1012/1013/2012/2013
				x		1015 No flame start system
x	x	x	x	x	x	TCD 2012 2V/4V Release (4): max. B100

* Engines with an earlier production date can be retrofitted. The head office can provide information about the scope of the retrofit.

Restrictions:

- Half the number of lubricating oil change intervals for the releases (1), (4) and (6)



**Engines without exhaust gas after-treatment
 up to emission stages US EPA Tier 3 / EU Stage IIIA / EURO III from year of production 1993***

Biodiesel according to EN 14214						
Biodiesel blends according to EN 16709 - High Fame Fuels (B20 and B30)						
Biodiesel blend according to EN 16734 (B10)						
US biodiesel according to ASTM D6751 (B100) (only for biodiesel blends with diesel fuel > 20 %(V/V)) only permitted for engines used in underground mining operation (MSHA: Mine Safety and Health Administration))						
US biodiesel blends according to ASTM D7467 (only for biodiesel blends with diesel fuel of 6-20 %(V/V))						
None of the named diesel fuels released by DEUTZ Minimum requirement according to appendix 14						
(1)	(2)	(3)	(4)	(5)	(6)	Series
x	x	x	x	x	x	TCD 2013 2V/4V Release (4): max. B100
x	x	x		x		TCD 2013 4V (Truck)
x	x	x	x	x	x	TCD 2015 From year of production 01.07.2010 Release (4): max. B50
				x	x	D/TD/TCD 2.9
				x	x	TD/TCD 3.6
				x	x	TCD 4.1/6.1/7.8
				x	x	TTCD 6.1/7.8
Emission downgrade engines						

* Engines with an earlier production date can be retrofitted. The head office can provide information about the scope of the retrofit.

Restrictions:
 – Half the number of lubricating oil change intervals for the releases (1), (4) and (6)

T1: Biodiesel releases



Engines with exhaust gas after-treatment
emission stages: US EPA Tier 4 interim / EU Stage IIIB / EURO IV / EURO V

Biodiesel according to EN 14214						
Biodiesel blends according to EN 16709 - High Fame Fuels (B20 and B30)						
Biodiesel blend according to EN 16734 (B10)						
US biodiesel according to ASTM D6751 (B100) (only for biodiesel blends with diesel fuel > 20 %(V/V)) only permitted for engines used in underground mining operation (MSHA: Mine Safety and Health Administration))						
US biodiesel blends according to ASTM D7467 (only for biodiesel blends with diesel fuel of 6-20 %(V/V))						
None of the named diesel fuels released by DEUTZ Minimum requirement according to appendix 14						
(1)	(2)	(3)	(4)	(5)	(6)	Series
x	x	x		x		TCD 2013 4V (Truck)
x	x	x		x		TCD 12.0 V6 / TCD 16.0 V8
x	x	x		x		TCD 4.1/6.1/7.8 (Agricultural engineering)
Restrictions:						
<ul style="list-style-type: none"> - Releases do not apply for engines with active DPF regeneration (burner) - Half the number of lubricating oil change intervals for release (1) - Replacement of SCR system after 4500 h if 100 % biodiesel is used following release (1) 						

T2: Biodiesel releases

Engines with exhaust gas after-treatment
emission stages: US EPA Tier 4 final / EU stage IV

Biodiesel according to EN 14214						
Biodiesel blends according to EN 16709 - High Fame Fuels (B20 and B30)						
Biodiesel blend according to EN 16734 (B10)						
US biodiesel according to ASTM D6751 (B100) (only for biodiesel blends with diesel fuel > 20 %(V/V)) only permitted for engines used in underground mining operation (MSHA: Mine Safety and Health Administration))						
US biodiesel blends according to ASTM D7467 (only for biodiesel blends with diesel fuel of 6-20 %(V/V))						
None of the named diesel fuels released by DEUTZ Minimum requirement according to appendix 14						
(1)	(2)	(3)	(4)	(5)	(6)	Series
x ¹	x	x		x		D/TD/TCD 2.9
x ¹	x	x		x		TD/TCD 3.6
x ¹	x	x		x		TCD 4.1
x ²	x	x		x		TCD 6.1/7.8
Restrictions:						
<ul style="list-style-type: none"> - Half the number of lubricating oil change intervals for release (1) - Replacement of SCR system if 100 % biodiesel is used following release (1) 						
x ¹ after 3000 h						
x ² after 4500 h						



Engines with exhaust gas after-treatment
emission stages: US EPA Tier 4 final / EU stage IV

Biodiesel according to EN 14214						
Biodiesel blends according to EN 16709 - High Fame Fuels (B20 and B30)						
Biodiesel blend according to EN 16734 (B10)						
US biodiesel according to ASTM D6751 (B100) (only for biodiesel blends with diesel fuel > 20 %(V/V)) only permitted for engines used in underground mining operation (MSHA: Mine Safety and Health Administration))						
US biodiesel blends according to ASTM D7467 (only for biodiesel blends with diesel fuel of 6-20 %(V/V))						
None of the named diesel fuels released by DEUTZ Minimum requirement according to appendix 14						
(1)	(2)	(3)	(4)	(5)	(6)	Series
x ²	x	x		x		TTCD 6.1/7.8
x ²	x	x		x		TCD 12.0 V6 / TCD 16.0 V8

Restrictions:

- Half the number of lubricating oil change intervals for release (1)
- Replacement of SCR system if 100 % biodiesel is used following release (1)

x¹ after 3000 h
x² after 4500 h

T3: Biodiesel releases

Basic conditions to be observed

- For new customers it must be ensured that all the necessary basic conditions are satisfied and release by the Sales department is available before using biodiesel.
- Turbocharged engines are excepted from the release for applications which are normally operated with a high load above 80% nominal power; these are, for example, engines in block type heating power stations.
- Because of the low heating value, a power loss of 5-9 % and an extra fuel consumption of 6-8 % in comparison with diesel fuel according to EN 590 is possible.

Blocking up of the injection pump is not allowed.

- The specifications on the lubricating oil intervals in tables T1 to T3 must be observed.
- In older series engines, the fuel hoses, the manual fuel supply pumps, and the LDA diaphragms (series 1012/1013/2012/2013/TCD 2012 2V mechanical and TCD 2013 2V mechanical) are partly not resistant to biodiesel and must be changed annually. Since the fuel hoses can dissolve prematurely at increasing fuel temperature and high running performance, they may have to be replaced before one year is up. The fuel hoses must be checked for damage (swelling) in the course of daily maintenance E 20. It is advisable to use biodiesel-resistant fuel hoses made of FKM materials (fluorinated rubber).

The engine series from emission stages US EPA Tier 4 interim / EU Stage IIIB / EURO IV have resistant elastomers. In this case, there is no need for an annual replacement.

Nevertheless, the entire fuel system should still be checked on a regular basis.

- Biodiesel can be mixed with standard diesel fuel. The basic conditions detailed in this section apply to mixtures with a biodiesel content of more than 7 %(V/V) (B7).
- In individual cases, mixtures of US biodiesel with diesel fuel are not very suitable for cold weather and are not recommended for the winter.
- Approx. 30-50 oh after changing over from diesel fuel to biodiesel, the fuel filter should be changed as a precaution to avoid a drop in performance due to clogged fuel filters. Deposited fuel-ageing products are dissolved by biodiesel and transported into the fuel filter. They should not be changed immediately, but after approx. 30 to 50 hours, because the dissolving of dirt takes a certain amount of time.



- All parts carrying fuel which are installed later (by OEM or end customers, e.g. fuel pre-filter and fuel pipes) must be suitable for operation with biodiesel.
- Downtime periods of longer than 4 weeks must be avoided with biodiesel. Otherwise the engine must be started and shut down with diesel fuel.
- Engines with a low annual running time, e.g. emergency power supply units, are excluded from operation with biodiesel.
- To improve the oxidation stability of the used biodiesel and to improve the storability and reduce deposits and clogging in the injection system, it is recommended to use the DEUTZ additive "DEUTZ Clean-Diesel InSyPro[®]" in the recommended concentration.

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Vegetable oils



Pure vegetable oils (e.g. rapeseed oil, soya oil, palm oil) are not classified as biodiesel and have problematic properties in engines which were not developed for vegetable oil operation (great tendency for coking, danger of piston seizure, extremely high viscosity, poor evaporation behaviour).

DEUTZ Natural Fuel Engine[®]

DEUTZ has developed the first series engine based on the TCD 2012 2V/4V series with the DEUTZ Common Rail System[®] (DCR) for use with rapeseed oil.

These engines are released for use of 100 % (V/V) rapeseed oil (refined or cold pressed) according to DIN 51605 (appendix 15) and biodiesel according to EN 14214 (appendix 8) or a biodiesel blend according to EN 16709 (appendix 9 and appendix 10) and EN 16734 (appendix 11).

Fuel	Specifications
Rapeseed oil fuel according to DIN 51605	Appendix 15

Basic conditions to be observed

- Due to the low heating value, a power loss of 5-10 % and an extra fuel consumption of 4-5 % in comparison with diesel fuel according to EN 590 is possible.
Blocking up of the injection pump is not allowed.
- The engine is a two-tank system which switches between diesel fuel and rapeseed oil. Alternatively biodiesel can be used instead of rapeseed oil or diesel fuel.
- At temperatures below 5 °C, rapeseed oil should be replaced by diesel fuel or biodiesel.
- Downtime periods of longer than 4 weeks must be avoided with biodiesel and rapeseed oil. Otherwise the engine must be started and shut down with diesel fuel.
- The lubricating oil change interval must be halved in comparison with operation with diesel fuel according to EN 590.
- Important fuel properties such as water content, oxidation stability, calcium, magnesium and phosphorus content and the total contamination are influenced especially by the harvest time, the pressing process in the oil mill, the storage of the rapeseed oil and the further logistics chain. Due to the limit values at distributed oil mills being frequently exceeded, the user is recommended to have the quality of the rapeseed fuel delivery confirmed by an analysis certificate. In cases of doubt, the quality can be certified by an analysis carried out by a laboratory accredited according to ISO 17025, (e.g. ASG Analytik GmbH, D-86356 Neusäß, Tel. +49 (0)821-450-423-0).
- Mixtures with other vegetable oils such as sunflower seed oil, soya oil or palm oil are not permissible because these vegetable oils can have problematic properties (strong coking tendency, danger of piston seizure, poorer low-temperature properties, increased oxidation tendency).
- To increase the oxidation stability of the used rape seed oil and to improve the storability and reduce deposits and clogging in the injection system, it is recommended to use the DEUTZ additive "DEUTZ Clean-Diesel InSyPro[®]" in the recommended concentration.



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Instructions for the storage of rapeseed oil in fuel stations for own use

- To be stored in dark places at constant low temperatures (maximum 20 °C, optimal in ground tanks at 5 - 10 °C). Storage temperatures below freezing point should be avoided, ground tanks are also optimal in this respect. The tanks may not be permeable to light (no polythene tanks).
- The storage time for rapeseed oil should be limited to a maximum of 6 months at storage temperatures up to 20 °C, for ground tanks < 10 °C maximum 12 months).
- Due to the hygroscopic (attracting water) properties of rape seed oil, works fuel stations should if possible be fitted with dehumidification on the air exchange system.
- Minimise contact with air using tight seals.
- Contact with metals with a catalytic effect, particularly copper or brass, must be avoided at all costs. These materials must not be used at all in the storage system (e.g. pipes, screw connections, pumps, etc.).
- Avoid gathering of sediments by removal approx. 10 cm above the tank floor.
- The tanks should be regularly cleaned and, if a bacterial infestation occurs, the bactericide Grotamar® 71 or 82 should be used by a specialised firm.

Series diesel engines

The conversion of other DEUTZ engines to operation with pure vegetable oil with conversion kits and modified tank systems of various manufacturers is not allowed and leads to loss of the warranty rights.

Only engines of the 912W/913W/413FW/413W series with the 2-tank system from Henkelhausen, D-47809 Krefeld, Fax no. +49 (0)2151 574 112, can be operated with rapeseed oil fuel according to DIN 51605, see appendix 15.

Jet fuels

The following jet fuels can be used:

Kerosene fuel	Specifications
F-34 (NATO designation)	Specifications available on request
F-35 (NATO designation)	
F-44 (NATO designation)	
F-63 (NATO designation, equivalent to F-34/F-35 with additives)	
F-65 (NATO designation, 1:1 mixture of F-54 and F-34/F-35)	
JP-8 (US military designation)	
JP-5 (US military designation)	
Jet A (for civil aviation)	
Jet A1 (for civil aviation)	

Released engines

- Engines **without** a common rail injection system and without external exhaust gas recirculation up to Tier 3 / Stage IIIA and EURO III
 - 413/513/912/913/914
 - 1011/2011/1012/1013/2012/2013/1015
 - TCD 2011/TCD 2012/TCD 2013
 - TCD 2015
- Engines **with** a common rail injection system
 - Genset COM II
 - TCD 2013 L06



Tier 3 / Stage IIIA / EURO III

– TCD 2012 2V/TCD 2013 2V/TCD 2013 4V

Without external exhaust gas recirculation

- All engines with exhaust gas after-treatment are not released for jet fuels either.
- Releases are exclusively restricted to official and special vehicles.

Basic conditions to be observed

- The cetane number must be at least 40, otherwise starting difficulties, extreme white smoke or increased hydrocarbon emissions may occur.
- Because of the lower density and the greater leak fuel volume due to lower viscosity, depending on the engine speed and torque, a power loss between 3 - 10 % is possible.



ATTENTION

An increase in the fuel injection rate is impermissible!

- There are some problematic fuel properties amongst the listed jet fuels (viscosity, high sulphur content, low lubricity and low boiling point). A slight increase in wear in the injection system is to be expected, which can lead to a statistically shorter service life of these components. The warranty is maintained when these fuels are used.
- Jet fuels can be mixed together and with diesel fuel.

Marine distillate fuels

This includes distillate fuels which are used in shipping. Only marine distillate fuels which contain no residue oils (residue from the distillation process) may be used.

The following marine fuels may be used:

Fuel	Specifications
ISO 8217 DMX	Appendix 16
ISO 8217 DMA (restriction: sulphur content max. 1.0 %(m/m))	Appendix 16
NATO F-75	Specifications available on request
NATO F-76	

Released engines

- The releases only apply to the following DEUTZ marine engines:
 - 413/513/912/913/914M
 - 1013M
 - 1015M/2015M

Basic conditions to be observed

- The cetane number must be at least 40, otherwise starting difficulties, extreme white smoke or increased hydrocarbon emissions may occur.
- At a density of $> 0.869\text{g/cm}^3$, a return blocking in the injection pump is necessary (may only be carried out by authorised DEUTZ personnel).
- The possible high sulphur content $\geq 0.5 \text{ %(m/m)}$ requires a shorter lubricating oil change interval. Fuels with a sulphur content $> 1.0 \text{ %(m/m)}$ are not permissible due to higher corrosion and considerable shortening of the engine life. It must therefore be pointed out that fuels in accordance with ISO 8217 DMA are only permissible when the maximum sulphur content is 1.0 %(m/m) .
- Low-ash oils (low SAPS) are not permissible at sulphur contents $> 50 \text{ mg/kg}$ or $> 500 \text{ mg/kg}$, i.e. generally not suitable for marine distillate fuels.



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- Due to the possible heavier contamination, great emphasis must be placed on fuel cleaning and possibly the installation of an additional fuel filter with a water trap to avoid biological contamination in particular.

Biological contamination in fuels

Symptoms

The following symptoms may indicate that a fuel tank is contaminated by micro-organisms:

- Corrosion of inside of tank
- Filter blockage and associated loss of power due to gel-like deposits on the fuel filter (especially after prolonged downtime periods)

Cause

Micro-organisms (bacteria, yeast, fungi) can multiply into biological sludge under favourable conditions (especially favoured by heat and water).

The water entry is usually caused by condensation of the water contained in the air. Water dissolves poorly in fuel, so the water which enters sinks to the bottom of the tank. The bacteria and fungi grow in the aqueous phase at the boundary with the fuel phase from which they draw their nutrition. There is an increased risk especially with biogenic fuels or biodiesel blends.

Remedial measures

- Keep storage tanks clean, regular tank cleaning (including the fuel line) by specialist companies.
- Installation of fuel pre-filters with water traps, especially in countries with frequently fluctuating fuel qualities and high percentage of water (e.g. Separ-filter or RACOR filter).
- Use of biocide Grotamar[®] 71 or Grotamar[®] 82 provided by

Schülke & Mayr GmbH,
D-22840 Norderstedt,
Tel.: +49 (0)4052 100-0,
E-mail: info@schuelke.com

if fuel system and storage tank are already contaminated by micro-organisms. The biocide must be dosed according to the manufacturer's specifications.

The tank must be cleaned before adding the biocide if there is a clearly visible biofilm in the tank or on the tank walls.



Use is restricted exclusively to eliminating microbe contamination. Prophylactic use is not permissible.

- In suspicious cases, biological contamination according to DIN 51441 (determination of the number of colonies in mineral oil products in the boiling range below 400 °C) can be analysed by laboratories certified according to ISO 17025 (e.g. Petrolab GmbH, Brunckstraße 12, D-67346 Speyer, Germany, Tel.: +49 (0) 6232-33011).

Alternatively, the mikrocount[®] fuel test kits from Schülke & Mayr GmbH can be used.

- Appropriate quick check kits are also available from the biocide suppliers.
- Avoid direct radiation of sunlight on the storage tank.
- Use of smaller storage tanks with correspondingly short dwell times of the stored fuel.
- Equip the fuel tank with a drying cartridge on the air exchange system.



Tank system maintenance

Instructions for proper tank system maintenance can be found in the Technical Report CEN/TR 15367-1:2015-12 (Petroleum products - Guidelines for good housekeeping - Part 1: Automotive diesel fuels).

Fuel additives

The DEUTZ Clean-Diesel InSyPro[®] additive is released exclusively for use in DEUTZ engines.

Information on use and dosing:



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The previously mentioned flow improvers are an exception. The use of other fuel additives is impermissible. Voiding of the warranty is to be expected when unsuitable additives are used which have not been released.

Fuel filter

Modern diesel engines, especially with high-pressure injection and common rail injection system make very high demands on the fuel quality. The **DEUTZ original fuel filters** are adapted and tested for these demands. Continuous, trouble-free operation of the engines is only guaranteed when the original filters are used. In the event of damage to the injection system within the warranty period and proof that no original filters were used, the warranty will be voided.

Contact

If you have questions about any of the topics mentioned here, please contact us using the details given below:

Email: lubricants.de@deutz.com

or

Email: service-kompaktmotoren.de@deutz.com

For the America region:

Email: service@deutzusa.com

For the Asia region:

Email: dapservice@deutz.com

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Appendix 1

General information on fuel properties and exhaust gas after-treatment systems

Exhaust gas after-treatment systems

The introduction of new, strict exhaust emission regulations demands the use of exhaust gas after-treatment systems such as the SCR technique (selective catalytic reduction) and the closed diesel particle filter (DPF). For the trouble-free use of fuels, it is necessary to reduce ash and deposit-forming elements as well as elements which damage the catalytic converter, such as sulphur, as much as possible. Therefore, these engines may only be operated with sulphur-free diesel fuels (EN 590, ASTM D975 Grade 2-D S15, ASTM D975 Grade 1-D S15 or heating oil or non-road fuels in EN 590 quality (sulphur content max. 10 mg/kg)). Other elements such as phosphorus, calcium, magnesium, sodium and potassium, which especially biogenic fuels may contain, should also be minimised. Otherwise, compliance with the emission requirements and durability of the exhaust gas after-treatment systems is not guaranteed.

Ash

Ash is carbon-free combustion residue, which can lead to wear due to deposits in the engine and turbocharger.

Biodiesel

Biodiesel is made by re-estering of greases or oils (triglyceride) with methanol. The correct chemical name is fatty acid methyl ester, often abbreviated to FAME. In Europe it is usually produced by re-estering of rapeseed oil (rapeseed oil methyl ester = RME). In the USA, biodiesel comes almost exclusively from soya oil (soya methyl ester = SME). Other vegetable oils (sunflower oil, palm oil, jatropha oil), animal fats or used vegetable oils (frying fats) are also possible as raw materials.

Due to national and EU regulations, biodiesel (FAME) percentages are now possible or prescribed in most diesel fuels. In the new EN 590, max. 7 % (V/V) is permissible for example, in the US-ASTM D975 max. 5 % (V/V).

Cetane number/cetane index

The cetane number indicates the fuel's ignitibility. Too low a cetane number may lead to starting difficulties, formation of white smoke, increased carbon emissions and thermal and mechanical overloading of the engine. The cetane number is determined on a test engine. The cetane index can be substituted as a value calculated from density and boiling behaviour. The cetane index serves for estimating the cetane number for the basic fuel, but it does not usually take the effect of ignitibility improvers into account when the cetane number of finished fuels is determined.

Density

The density is usually specified in g/cm^3 or kg/m^3 at 15 °C and is important for converting the fuel consumption from volume to mass unit. The higher the density, the greater the mass of the injected fuel.

Flashpoint

The flashpoint has no significance for the engine operation. It applies as a value for the flammability and is important for classification into one of the hazard classes (crucial for storage, transport and insurance).

Heating value

The lower heating value (H_L) indicates the amount of heat which is released when burning 1 kg of fuel.

Low-temperature performance

The following parameters indicate the suitability of the fuel for low temperatures:

- The solidification point indicates at what temperature the fuel no longer flows under its own weight.



- The pour point is approx. 3 °C above the solidification point.
- The cloud point indicates at what temperature solid emissions (paraffin crystals) become visible.
- The limit of filtrability (CFPP) indicates at what temperature filters and pipes may be blocked and is determined nationally or regionally for specific climatic regions (summer/transitional/winter period). For engines that are used only temporarily, the corresponding low-temperature performance must be considered.

Coke residue

The coke residue serves as a reference value for the tendency for residues to form in the combustion chamber.

Copper corrosion

Diesel fuel can be corrosive, especially during prolonged storage with fluctuating temperature and formation of condensation on the tank walls. To check the limit value defined in DIN EN 590, a polished copper strip is immersed in diesel fuel at 50 °C for 3 hours. Appropriate additives ensure protection of the metals which come into contact with the fuel even under difficult conditions.

Neutralisation number

The neutralisation number is a measure of the content of free acids in the diesel fuel or biodiesel fuel. It describes the amount of caustic potash required for neutralising the acids. Acid compounds in the fuel lead to corrosion, wear and formation of residue in the engine.

Oxidation resistance

Fuels may oxidise and polymerise partly during prolonged storage. This can lead to the formation of insoluble (varnish like) components and the associated filter blockage. Biofuel parts are more sensitive to oxidation and impair oxidation resistance as a result.

Lubricity

The lubricity decreases with the degree of desulphurisation and can drop to a level that leads to considerable wear in the distributor injection pumps and common rail systems. Extremely desulphurised fuels contain special lubricity additives. The HFRR test (High Frequency Reciprocating Wear Rig) was developed for evaluating the fuels (EN ISO 12156-1). This test simulates the sliding wear in the injection pump by rubbing a ball on a polished steel plate with constant contact force. The flattening of the ball after 75 minutes is measured as an average wear diameter (limit value max. 460 µm).

Diesel fuels with a biodiesel content of at least 2 % always fulfil the lubricity properties of max. 460 µm according to EN ISO 12156-1.

Sulphur content

High sulphur content and low component temperature can cause increased wear due to corrosion. The sulphur content influences the lubricating oil change intervals. Too low a sulphur content may impair the lubricity of the fuel if this has not had lubricity improvers added.

Sediments/total contamination

Sediments are solids (dust, rust, scale) which can cause wear in the injection system and combustion chamber as well as leaks in the valves.

Boiling curve

The boiling curve indicates how much volume% of the fuel is overdistilled at a certain temperature. The greater the boiling residue (amount remaining after evaporation), the more combustion residue may occur in the engine, especially in partial load operation.

Trace elements in the fuel (zinc, lead, copper)

Even small traces of zinc, lead and copper can lead to deposits in the injection nozzles, especially in the modern common rail injection systems.



Zinc and lead coatings are therefore not permissible in tank systems (especially in fuel stations for own use) and fuel pipes. Materials containing copper (copper pipes, brass parts) must also be avoided because they can lead to catalytic reactions in the fuel with subsequent deposits in the injection system.

Conversion ppm

The term parts per million (ppm) is often used in fuel analyses.

The term ppm alone is not a unit of measure. It usually describes the weight concentration (1 ppm (m/m) = 1 mg/kg).

1 ppm = 10^{-6} = parts per million = 0.0001 %

Viscosity

The kinematic viscosity in mm^2/s at a certain temperature ($1 \text{ mm}^2/\text{s} = 1 \text{ cSt}$ [centistoke]) is specified. The viscosity must be within certain limits for engine operation. Too high a viscosity requires pre-heating because otherwise a lower engine performance is to be expected.

Water

Too high a water content leads to corrosion and, in connection with corrosion products and sediments, to sludge. Disturbances in the fuel and injection system are the result.

Fuel quality and exhaust gas legislation

The fuel qualities to be used are closely related to the used engine and exhaust gas after-treatment technologies and these are selected in turn with regard to the emission limits of the exhaust laws of the countries in which the engines are used.

Appendix 2

Fuel specification Diesel fuel according to EN 590 Edition April 2014

Properties	Units	Limit values	Test method
Cetane number	–	min. 51	EN ISO 5165 EN 15195 EN 16144
Cetane index	–	min. 46	EN ISO 4264
Density at 15 °C	kg/m^3	min. 820 max. 845	EN ISO 3675 EN ISO 12185
Polycyclic aromatic hydrocarbons	%(m/m)	max. 8.0	EN 12916
Sulphur content	mg/kg	max. 10.0	EN ISO 20846 EN ISO 20884 EN ISO 13032
Flashpoint	°C	min. 55	EN ISO 2719
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.30	EN ISO 10370
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Water content	mg/kg	max. 200	EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1	EN ISO 2160



Fuel specification
Diesel fuel according to EN 590
Edition April 2014

Properties	Units	Limit values	Test method
Oxidation stability	g/m ³	max. 25	EN ISO 12205
Oxidation stability at 110 °C	hours	min. 20	EN ISO 15751
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	max. 460	EN ISO 12156-1
Kinematic viscosity at 40 °C	mm ² /s	min. 2.0 max. 4.5	EN ISO 3104
Distillation			EN ISO 3405 EN ISO 3924
– collected at 250 °C	%(V/V)	max. 65	
– collected at 350 °C	%(V/V)	min. 85	
– 95 vol.% starting at	°C	max. 360	
Fatty Acid Methyl Ester (FAME)	%(V/V)	max. 7.0	EN 14078
Manganese content	mg/l	max. 2.0	EN 16576
Limit of filtrability* (CFPP)			EN 116 EN 16329
– 15.04. - 30.09.	°C	max. 0	
– 01.10. - 15.11.	°C	max. -10	
– 16.11. - 28.02. (in leap years 29.02.)	°C	max. -20	
– 01.03. - 14.04.	°C	max. -10	

* specifications apply for Germany. National regulations may deviate.

Appendix 3

Fuel specification
US diesel fuel according to ASTM D975-16a

Properties	Units	Limit values		Test method
		Grade No. 1-D S15	Grade No. 2-D S15	
Density at 15 °C	kg/m ³	max. 860*	max. 860*	ASTM D4052
Flashpoint	°C	min. 38	min. 52	ASTM D93
Water and sediments	%(V/V)	max. 0.05	max. 0.05	ASTM D2709
Boiling curve at 90 vol.%	°C	–	min. 282	ASTM D86
	°C	max. 288	max. 338	
Kinematic viscosity at 40 °C	mm ² /s	min. 1.3 max. 2.4	min. 1.9 max. 4.1	ASTM D445
Ash content	%(m/m)	max. 0.01	max. 0.01	ASTM D482
Sulphur content				
– Grade Low Sulphur No. 1/2-D S15	mg/kg	max. 15	max. 15	ASTM D5453
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	max. Class 3	max. Class 3	ASTM D130
Cetane number	–	min. 40	min. 40	ASTM D613
Cetane index	–	min. 40	min. 40	ASTM D976



Fuel specification

US diesel fuel according to ASTM D975-16a

Properties	Units	Limit values		Test method
		Grade No. 1-D S15	Grade No. 2-D S15	
Lubricity, HFRR at 60 °C	µm	max. 520	max. 520	ASTM D6079 ASTM D7688
Aromatic content	%(V/V)	max. 35	max. 35	ASTM D1319
Coke residue (from 10 % distillation residue) according to Ramsbottom	%(m/m)	0.15	0.35	ASTM D524
Limit of filtrability (CFPP)	°C	**	**	ASTM D4539 ASTM D6371
Cloud point	°C	**	**	ASTM D2500
Conductibility	pS/m	min. 25	min. 25	ASTM D2624 ASTM D4308
* DEUTZ restriction				
** depending on the season and region				

Appendix 4

Fuel specification

Japan diesel fuel according to JIS K 2204:2007

Properties	Units		Limit values				Test method	
			Special No. 1	No. 1	No. 2	No. 3		Special No. 3
Flashpoint	°C	min.	50				JIS K 2266-3	
Boiling curve at 90 vol. %	°C	max.	360	350	330	330	JIS K 2254	
Pour point	°C	max.	+5	-2.5	-7.5	-20	-30	JIS K 2269
Limit of filtrability (CFPP)	°C	max.	-	-1	-5	-12	-19	JIS K 2288
Coke residue (from 10 % distillation residue)	%(m/m)	max.	0.1				JIS K 2270	
Cetane index	-	min.	50	45			JIS K 2280	
Kinematic viscosity at 30 °C	%(V/V)	min.	2.7	2.5	2.0	1.7	JIS K 2283	
Sulphur content	mg/kg	max.	10				JIS K 2254-1, -2, -6, -7	
Density at 15 °C	kg/m ³	max.	860				JIS K 2249	
Fatty Acid Methyl Ester (FAME)	%(m/m)	max.	5				-	



Appendix 5

Minimum requirements for fuels in countries in which none of the named diesel fuels released by DEUTZ exist.

Parameter	Basic condition	Test method	Units	DEUTZ requirement	
				min.	max.
Density at 15 °C	–	ISO 3675 ISO 12185	kg/m ³	820 ¹	876 ²
Cetane number	Ambient temperatures > 0 °C	ISO 5156 ISO 15195	–	40.0	–
	Ambient temperatures < 0 °C	ASTM D613 ASTM D6890	–	45.0	–
Kinematic viscosity at 40 °C	Ambient temperatures > 0 °C	ISO 3104 ASTM D44	mm ² /s	1.8	5.0
	Ambient temperatures < 0 °C			1.2	4.0
Cloud point	–	–	°C	Not higher than the ambient temperature	
Pour point	–	ISO 3016 ASTM D97	°C	At least 5 °C lower than the ambient temperature	
Sulphur content	Engines without exhaust gas after-treatment ³	ISO 20846 ISO 20847	%(m/m)	–	1.0
	Engines with externally cooled exhaust gas recirculation and without exhaust gas after-treatment	ASTM D3605 ASTM D1552	mg/kg	–	500
	Engines with exhaust gas after-treatment		mg/kg	–	15
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	–	ISO 12156-1 ASTM D6079	µm	–	460
50 %V/V boiling temperature	–	ISO 3405	°C	–	282
90 %V/V boiling temperature	–	ASTM D86	–	–	360
Coke residue (from 10 % distillation residue)	–	ASTM D524	%(m/m)	–	0.35
Ash content	–	ISO 6245 ASTM D482	%(m/m)	–	0.01
Inorganic elements (Ca+Mg+Na+K)	Engines with exhaust gas after-treatment	EN 14108 EN 14109 EN 14538	mg/kg	–	5
Water content	–	ISO 12937	mg/kg	–	200 ⁴
Total contamination	–	EN 12662	mg/kg	–	24 ⁵
Alternative to water content and total contamination: Water and sediments	–	ASTM D473	%(V/V)	–	0.05
Corrosion effect on copper (3 h at 50 °C)	–	ISO 2160 ASTM D130	Degree of corrosion	–	3



Minimum requirements for fuels in countries in which none of the named diesel fuels released by DEUTZ exist.

Parameter	Basic condition	Test method	Units	DEUTZ requirement	
				min.	max.
Fatty Acid Methyl Ester (FAME)	–	EN 14078	%(V/V)	–	7.0 ⁶
¹ For Arctic diesel fuels, the lower density limit is 800 kg/m ³ at 15 °C.					
² At densities > 860 kg/m ³ at 15 °C, return blocking of the engine power by authorised DEUTZ dealers is necessary.					
³ At sulphur contents > 5000 mg/kg, the lubricating oil change intervals must be halved.					
⁴ Water contents up to 1000 mg/kg are possible when water-trapping fuel filters are used.					
⁵ At dirt contents > 24 mg/kg, fuel filters with a higher dirt capacity and very high efficiency must be used.					
⁶ Biodiesel content is based on national regulations and may be a little higher.					



If test methods other than the ones stipulated are used, the fuel supplier must provide evidence that these test methods are comparable in the event of dispute.

Appendix 6

Fuel specification
Light heating oil EL according to DIN 51603-1, low sulphur
Edition March 2017

Properties	Units	Limit values	Test method
Density at 15 °C	kg/m ³	max. 860	DIN 51757 EN ISO 12185
Combustion point	MJ/kg	min. 45.4	DIN 51900-1 DIN 51900-2 DIN 51900-3 or calculation
Flashpoint in closed pot according to Pensky-Martens	°C	min. 55	EN ISO 2719
Kinematic viscosity at 20 °C	mm ² /s	max. 6.0	DIN 51562-1
Distillation curve			EN ISO 3405
Total evaporated volume parts			
– up to 250 °C	%(V/V)	max. 65	
– up to 350 °C	%(V/V)	min. 85	
Cloud point	°C	max. 3	EN 23015
Limit of filtrability (CFPP) depending on the cloud point			EN 116
– at cloud point = 3 °C	°C	max. -12	
– at cloud point = 2 °C	°C	max. -11	
– at cloud point < 1 °C	°C	max. -10	
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.3	EN ISO 10370 DIN 51551-1



Fuel specification
Light heating oil EL according to DIN 51603-1, low sulphur
Edition March 2017

Properties	Units	Limit values	Test method
Sulphur content – for heating oil EL-1 low sulphur	mg/kg	max. 50	EN ISO 20884 EN ISO 20846
Water content	mg/kg	max. 200	DIN 51777-1 EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Thermal stability (sediment)	mg/kg	max. 140	DIN 51371
Note: Low-sulphur heating oil according to DIN 51603-1 has a sufficient lubricity of 460 µm (according to EN ISO 12156-1).			

Appendix 7

Fuel specification
Paraffinic diesel fuel from synthesis or hydrotreatment according to EN 15940
Edition September 2016

Properties	Units	Limit values				Test method
		Class A		Class B		
		min.	max.	min.	max.	
Cetane number	–	70.0	–	51.0	–	EN ISO 5165 EN 15195 DIN 51773
Density at 15 °C	kg/m ³	765	800	780	810	EN ISO 3675 EN ISO 12185
Flashpoint	°C	55.0	–	55.0	–	EN ISO 2719
Viscosity at 40 °C	mm ² /s	2.00	4.50	2.00	4.50	EN ISO 3104
Distillation						
– collected at 250 °C	%(m/m)	65	–	65	–	EN ISO 3405
– collected at 350 °C	%(m/m)	85	–	85	–	EN SIO 3924
– 95 %(m/m) collected at	°C	–	360	–	360	
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	–	460	–	460	EN ISO 12156-1
Fatty Acid Methyl Ester (FAME)	%(V/V)	–	7	–	7	EN 14078
Manganese content	mg/l	–	2.0	–	2.0	EN 16136
Total aromatic content	%(m/m)	–	1.1	–	1.2	EN 12916
Sulphur content	mg/kg	–	5	–	5	EN ISO 20846 EN ISO 20884
Coke residue (from 10 % distillation residue)	%(m/m)	–	0.30	–	0.30	EN ISO 10370
Ash content	%(m/m)	–	0.01	–	0.01	EN ISO 6245
Water content	mg/kg	–	200	–	200	EN ISO 12937
Total contamination	mg/kg	–	24	–	24	EN 12662
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1		Class 1		EN ISO 2160



Fuel specification

Paraffinic diesel fuel from synthesis or hydrotreatment according to EN 15940
Edition September 2016

Properties	Units	Limit values				Test method
		Class A		Class B		
		min.	max.	min.	max.	
Oxidation stability	g/m ³	–	25	–	25	EN ISO 12205
Oxidation stability at 110 °C	hours	min.	20	min.	20	EN 15751
Limit of filtrability* (CFPP)						EN 116
– 15.04. - 30.09.	°C	–	0	–	0	EN 16329
– 01.10. - 15.11.	°C	–	-10	–	-10	
– 16.11. - 28.02. (in leap years 29.02.)	°C	–	-20	–	-20	
– 01.03. - 14.04.	°C	–	-10	–	-10	

* specifications apply for Germany. National regulations may deviate.

Appendix 8

Fuel specification

Fatty acid methylesters (FAME) for use in diesel engines and as heating oil in accordance with EN 14214
Edition June 2014

Properties	Units	Limit values		Test method
Fatty Acid Methyl Ester (FAME)	%(m/m)	min.	96.5	EN 14103
Density at 15 °C	kg/m ³	min.	860	EN ISO 3675
		max.	900	EN ISO 12185
Viscosity at 40 °C	mm ² /s	min.	3.5	EN ISO 3104
		max.	5.0	
Flashpoint	°C	min.	101	EN ISO 2719
				EN ISO 3679
Sulphur content	mg/kg	max.	10	EN ISO 20846
				EN ISO 20884
				EN ISO 13032
Cetane number	–	min.	51.0	EN ISO 5165
Ash content (Sulphate ash)	%(m/m)	max.	0.02	ISO 3987
Water content	mg/kg	max.	500	EN ISO 12937
Total contamination	mg/kg	max.	24	EN 12662
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1		EN ISO 2160
Oxidation stability at 110 °C	hours	min.	8.0	EN 15751
				EN 14112
Acid number	mg KOH/g	max.	0.50	EN 14104
Iodine number	g Iodine/100 g	max.	120	EN 14111
				EN 16300
Content of linolenic acid methyl ester	%(m/m)	max.	12.0	EN 14103
Content of multiple unsaturated fatty acid methyl esters with ≥ 4 double bonds	%(m/m)	max.	1.00	EN 15779



Fuel specification

Fatty acid methylesters (FAME) for use in diesel engines and as heating oil in accordance with EN 14214

Edition June 2014

Properties	Units	Limit values	Test method
Methanol content	%(m/m)	max. 0.20	EN 14110
Monoglyceride content	%(m/m)	max. 0.70	EN 14105
Diglyceride content	%(m/m)	max. 0.20	EN 14105
Triglyceride content	%(m/m)	max. 0.20	EN 14105
Content of free glycerine	%(m/m)	max. 0.02	EN 14105 EN 14106
Content of total glycerine	%(m/m)	max. 0.25	EN 14105
Content of alkaline metals (Na + K)	mg/kg	max. 5.0	EN 14108 EN 14109 EN 14538
Content of earth alkaline metals (Ca + Mg)	mg/kg	max. 5.0	EN 14538
Phosphor content	mg/kg	max. 4.0	EN 14107 EN 16294
Limit of filtrability* (CFPP)			EN 116
– 15.04. - 30.09.	°C	max. 0	EN 16329
– 01.10. - 15.11.	°C	max. -10	
– 16.11. - 28.02. (in leap years 29.02.)	°C	max. -20	
– 01.03. - 14.04.	°C	max. -10	

* specifications apply for Germany. National regulations may deviate.

Appendix 9

Fuel specification

Fuel with high FAME content (B20) according to EN 16709

Edition December 2015

Properties	Units	Limit values	Test method
Fatty Acid Methyl Ester (FAME)	%(V/V)	min. 14.0 max. 20.0	EN 14078
Cetane number	–	min. 51	EN ISO 5165 EN 15195 EN 16144
Density at 15 °C	kg/m ³	min. 820 max. 860	EN ISO 3675 EN ISO 12185
Flashpoint	°C	min. 55.0	EN ISO 2719
Viscosity at 40 °C	mm ² /s	min. 2.00 max. 4.62	EN ISO 3104
Sulphur content	mg/kg	max. 10.0	EN ISO 20846 EN ISO 20884 EN ISO 13032
Manganese content	mg/l	max. 2.0	EN 16576
Polycyclic aromatic hydrocarbons	%(m/m)	max. 8.0	EN 12916
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Water content	mg/kg	max. 260	EN ISO 12937



Fuel specification
Fuel with high FAME content (B20) according to EN 16709
Edition December 2015

Properties	Units	Limit values	Test method
Total contamination	mg/kg	max. 24	EN 12662
Oxidation stability	hours	min. 20	EN 15751
Distillation			EN ISO 3405
– collected at 250 °C	%(V/V)	max. 65	EN ISO 3924
– collected at 350 °C	%(V/V)	min. 85	
– 95 vol.% starting at	°C	max. 360	
Limit of filtrability* (CFPP)			EN 116
– 15.04. - 30.09.	°C	max. 0	EN 16329
– 01.10. - 15.11.	°C	max. -10	
– 16.11. - 28.02. (in leap years 29.02.)	°C	max. -20	
– 01.03. - 14.04.	°C	max. -10	

* specifications apply for Germany. National regulations may deviate.

Appendix 10

Fuel specification
Fuel with high FAME content (B30) according to EN 16709
Edition December 2015

Properties	Units	Limit values	Test method
Fatty Acid Methyl Ester (FAME)	%(V/V)	min. 24.0 max. 30.0	EN 14078
Cetane number	–	min. 51	EN ISO 5165 EN 15195 EN 16144
Density at 15 °C	kg/m ³	min. 825 max. 865	EN ISO 3675 EN ISO 12185
Flashpoint	°C	min. 55.0	EN ISO 2719
Viscosity at 40 °C	mm ² /s	min. 2.00 max. 4.65	EN ISO 3104
Sulphur content	mg/kg	max. 10.0	EN ISO 20846 EN ISO 20884 EN ISO 13032
Manganese content	mg/l	max. 2.0	EN 16576
Polycyclic aromatic hydrocarbons	%(m/m)	max. 8.0	EN 12916
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Water content	mg/kg	max. 290	EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Oxidation stability	hours	min. 20	EN 15751
Distillation			EN ISO 3405
– collected at 250 °C	%(V/V)	max. 65	EN ISO 3924
– collected at 350 °C	%(V/V)	min. 85	
– 95 vol.% starting at	°C	max. 360	



Fuel specification
Fuel with high FAME content (B30) according to EN 16709
Edition December 2015

Properties	Units	Limit values	Test method
Limit of filtrability (CFPP)			EN 116
– 15.04. - 30.09.	°C	max. 0	EN 16329
– 01.10. - 15.11.	°C	max. -10	
– 16.11. - 28.02. (in leap years 29.02.)	°C	max. -20	
– 01.03. - 14.04.	°C	max. -10	
* specifications apply for Germany. National regulations may deviate.			

Appendix 11

Fuel specification
Fuel with FAME content (B10) according to EN 16734
Edition November 2016

Properties	Units	Limit values	Test method
Fatty Acid Methyl Ester (FAME)	%(V/V)	max. 10.0	EN 14078
Cetane number	–	min. 51	EN ISO 5165 EN 15195 EN 16144 EN 16715
Cetane index	–	min. 46	EN ISO 4264
Density at 15 °C	kg/m ³	min. 820 max. 845	EN ISO 3675 EN ISO 12185
Flashpoint	°C	min. 55.0	EN ISO 2719
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.30	EN ISO 10370
Viscosity at 40 °C	mm ² /s	min. 2.0 max. 4.5	EN ISO 3104
Sulphur content	mg/kg	max. 10.0	EN ISO 20846 EN ISO 20884 EN ISO 13032
Manganese content	mg/l	max. 2.0	EN 16576
Polycyclic aromatic hydrocarbons	%(m/m)	max. 8.0	EN 12916
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Water content	mg/kg	max. 290	EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Oxidation stability	g/m ³	max. 25	EN ISO 12205
Oxidation stability	hours	min. 20	EN 15751
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	max. 460	EN ISO 12156-1
Distillation			EN ISO 3405 EN ISO 3924
– collected at 250 °C	%(V/V)	max. 65	
– collected at 350 °C	%(V/V)	min. 85	
– 95 vol.% starting at	°C	max. 360	
Limit of filtrability* (CFPP)			EN 116



Fuel specification

Fuel with FAME content (B10) according to EN 16734
Edition November 2016

Properties	Units	Limit values	Test method
- 15.04. - 30.09.	°C	max. 0	EN 16329
- 01.10. - 15.11.	°C	max. -10	
- 16.11. - 28.02. (in leap years 29.02.)	°C	max. -20	
- 01.03. - 14.04.	°C	max. -10	

* specifications apply for Germany. National regulations may deviate.

Appendix 12

Fuel specification

US biodiesel according to ASTM D6751-15c (B100)

Properties	Units	Limit values Grade S15	Test method
Calcium and Magnesium (together)	mg/kg	max. 5	EN 14538
Flashpoint	°C	min. 93	ASTM D93
Water and sediments	%(V/V)	max. 0.05	ASTM D2709
Kinematic viscosity at 40 °C	mm ² /s	min. 1.9 max. 6.0	ASTM D445
Ash content (Sulphate ash)	%(m/m)	max. 0.02	ASTM D874
Sulphur content	mg/kg	max. 15	ASTM D5453
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	max. Class 3	ASTM D130
Cetane number	-	min. 47	ASTM D613
Cloud point	°C	to be specified	ASTM D2500
Coke residue	%(m/m)	max. 0.05	ASTM D4530
Acid number	mg KOH/g	max. 0.50	ASTM D664
Methanol content	%(m/m)	max. 0.20	EN 14110
Content of free glycerine	%(m/m)	max. 0.02	ASTM D6584
Content of total glycerine	%(m/m)	max. 0.24	ASTM D6584
Phosphor content	%(m/m)	max. 0.001	ASTM D4951
Boiling curve at 90 vol. %	°C	max. 360	ASTM D1160
Sodium and potassium (together)	mg/kg	max. 5	EN 14538
Oxidation stability at 110 °C	hours	min. 3	EN 14112 EN 15751



Appendix 13

Fuel specification

US biodiesel blends according to ASTM D74675-15c (B6 to B20)

Properties	Units	Limit values	Test method
Biodiesel content	%(V/V)	min. 6 max. 20	ASTM D7371
Flashpoint	°C	min. 52	ASTM D93
Water and sediments	%(V/V)	max. 0.05	ASTM D2709
Kinematic viscosity at 40 °C	mm ² /s	min. 1.9 max. 4.1	ASTM D445
Ash content (oxide ash)	%(m/m)	max. 0.01	ASTM D482
Sulphur content	mg/kg	max. 15	ASTM D5453
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	max. Class 3	ASTM D130
Cetane number	–	min. 40	ASTM D613
Cloud point or LTFT/CFPP	°C	to be specified	ASTM D2500 ASTM D4539 ASTM D6371
Coke residue	%(m/m)	max. 0.35	ASTM D524
Acid number	mg KOH/g	max. 0.30	ASTM D664
Boiling curve at 90 vol.%	°C	max. 343	ASTM D86
Lubricity, HFRR at 60 °C	µm	max. 520	ASTM D6079
Oxidation stability at 110 °C	hours	min. 6	EN 15751
Limit of filtrability* (CFPP)			EN 116

* Country-dependent and dependent on the type of application in cold seasons.

Appendix 14

Minimum requirements for biodiesel fuels (FAME) in countries in which none of the named biodiesel fuels released by DEUTZ exist.

Properties	Units	Limit values	Test method
Fatty Acid Methyl Ester (FAME)	%(m/m)	min. 96.5	EN 14103
Density at 15 °C	kg/m ³	min. 860 max. 900	EN ISO 3675 EN ISO 12185
Viscosity at 40 °C	mm ² /s	min. 1.9 max. 6.0	ASTM D445 EN ISO 3104
Flashpoint	°C	min. 93	ASTM D93 EN ISO 2719 EN ISO 3679
Sulphur content	mg/kg	max. 10	ASTM D5453 EN ISO 20846 EN ISO 20884 EN ISO 13032
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.30	EN ISO 10370



Minimum requirements for biodiesel fuels (FAME) in countries in which none of the named biodiesel fuels released by DEUTZ exist.

Properties	Units	Limit values	Test method
Cetane number	–	min. 47	ASTM D664 EN ISO 5165
Ash content (Sulphate ash)	%(m/m)	max. 0.02	ASTM D874 ISO 3987
Water content	mg/kg	max. 500	ASTM D2709 EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1	EN ISO 2160
Oxidation stability at 110 °C	hours	min. 6	EN 15751 EN 14112
Acid number	mg KOH/g	max. 0.50	ASTM D664 EN 14104
Iodine number	g Iodine/100 g	max. 130	EN 14111 EN 16300
Content of linolenic acid methyl ester	%(m/m)	max. 12.0	EN 14103
Content of multiple unsaturated fatty acid methyl esters with ≥ 4 double bonds	%(m/m)	max. 1.00	EN 15779
Methanol content	%(m/m)	max. 0.20	EN 14110
Monoglyceride content	%(m/m)	max. 0.70	EN 14105
Diglyceride content	%(m/m)	max. 0.20	EN 14105
Triglyceride content	%(m/m)	max. 0.20	EN 14105
Content of free glycerine	%(m/m)	max. 0.02	EN 14105 EN 14106
Content of total glycerine	%(m/m)	max. 0.25	EN 14105
Content of alkaline metals (Na + K)	mg/kg	max. 5.0	EN 14108 EN 14109 EN 14538
Content of earth alkaline metals (Ca + Mg)	mg/kg	max. 5.0	EN 14538
Phosphor content	mg/kg	max. 10.0	ASTM D4951 EN 14107 EN 16294
Limit of filtrability* (CFPP)	°C	to be specified	EN 116 EN 16329

* Country-dependent and dependent on the type of application in cold seasons.



If test methods other than the ones stipulated are used, the fuel supplier must provide evidence that these test methods are comparable in the event of dispute.

Appendix 15

Fuel specification
Rapeseed oil fuel according to DIN 51605
Edition January 2016

Properties	Units	Limit values		Test method
Visual assessment	–	Free from visible contamination and sediments and free water		–
Density at 15 °C	kg/m ³	min.	910	EN ISO 3675
		max.	925	EN ISO 12185
Flashpoint according to Pensky-Martens	°C	min.	101	EN ISO 2719
Kinematic viscosity at 40 °C	mm ² /s	max.	36.0	EN ISO 3104 DIN 51659-2
Heating value	kJ/kg	min.	36000	DIN 51900-1, -2, -3
Willingness to ignite	–	min.	40	EN 15195
Iodine number	g Iodine/100 g	max.	125	EN ISO 3961
Sulphur content	mg/kg	max.	10	EN ISO 20884 EN ISO 20846
Total contamination	mg/kg	max.	24	EN 12662
Acid number	mg KOH/g	max.	2.0	EN 14104
Oxidation stability at 110 °C	hours	min.	6.0	EN 14112
Phosphor content	mg/kg	max.	3.0	DIN 51627-6
Calcium content	mg/kg	max.	1.0	DIN 51627-6
Magnesium content	mg/kg	max.	3.0	DIN 51627-6
Water content	mg/kg	max.	750	EN ISO 12937

Appendix 16

Fuel specification
Marine distillate fuel (marine fuels) according to ISO 8217
Edition December 2013

Properties	Units	Limit values			Test method
		Category ISO-F			
			DMX	DMA	
Kinematic viscosity at 40 °C	mm ² /s	min. max.	1.4 5.5	2.0 6.0	ISO 3104
Density at 15 °C	kg/m ³	–*	–*	890*	ISO 3675 ISO 12185
Cetane number	–	min.	45	40	ISO 4264
Sulphur content	%(m/m)	max.	1.0**	1.0**/**	ISO 8754 ISO 14596
Flashpoint	°C	min.	43	60	ISO 2719
Hydrogen sulphide	mg/kg	max.	2.00	2.00	IP 570
Acid number	mg KOH/g	max.	0.5	0.5	ASTM D664
Oxidation stability	g/m ³	max.	25	25	ISO 12205



Fuel specification
Marine distillate fuel (marine fuels) according to ISO 8217
Edition December 2013

Properties	Units	Limit values			Test method
		Category ISO-F			
		DMX	DMA		
Coke residue (from 10 % distillation residue)	%(m/m)	max.	0.30	0.30	ISO 10370
Cloud point	°C	max.	-16	–	ISO 3015
Pour point					ISO 3016
– Winter quality	°C	max.	–	-6	
– Summer quality	°C	max.	–	0	
Ash content	%(m/m)	max.	0.01	0.01	ISO 6245
Visual inspection	–	clear and transparent			–
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	max.	520	520	ISO 12156-1
* DEUTZ restriction					
** observe shorter lubricating oil maintenance interval					