Technical Circular

0199-99-01218/5 EN

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DEUTZ engines

- All DEUTZ diesel engines

Fuels

(Diesel engines)

Alterations

In comparison to TR 0199-99-01218/4, the following changes have been made:

Introduction

- New engine series
  - 1.2
  - 2.2
  - 9.0 / 12.0 L / 13.5 / 18.0
  - Currently released engines with emission stage EU Stage V
- DEUTZ fuel additives 14
  - DEUTZ StartBoost
  - DEUTZ FlowBoost
- EU fuel labelling 14

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General

This bulletin defines which fuels are approved for DEUTZ diesel engines (compact engines).

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 bulletin applies accordingly.

Only fuels specified in the respective national regulations and fuels for which the engines are certified with the corresponding valid emission regulation are to be used (for example, no fuel may be used in Europe if it only meets the limits of the US standard).

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 described in the following section, such as EN 590, ASTM D975 or EN 15940, for example. 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 nationally released fuel was used by providing a certificate from the fuel supplier.

Released fuels

Due to the large quantity of variants and body of emissions legislation, a simple overview in a table is no longer possible. The customer must therefore observe the appropriate releases and restrictions in the respective chapters.

Diesel fuels

All DEUTZ diesel 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. In winter, it is generally recommended to use fuels with a higher cetane number than the minimum requirement of 40.

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

Fuel		Specifications
EN 590	Biodiesel content max. 7 %(V/V)	Appendix 1
ASTM D975 Grade 1-D S15	Biodiesel content max. 5 %(V/V)	Appendix 2
ASTM D975 Grade 2-D S15		
JIS K 2204		Appendix 3
China diesel fuel according to GB 19147		Appendix 4
NATO F-54		on request

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.

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. An adequate lubricating capacity is guaranteed by the appropriate additives at the refinery in sulphur-free diesel fuels according to EN 590 and ASTM D 975. The parameter for sufficient lubricating capacity is, in EN 590 for example, a maximum wear spot of 460 µm 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 > 0.2 %(m/m) (2000 mg/kg) demand a shorter lubricating oil change interval.

– TR 0199-99-01217
Lubricating oil
(diesel engines)

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 (DEUTZ DQC II-18 LA, DQC III-18 LA, DQC IV-18 LA) 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 in winter.

Diesel fuels up to -44 °C are available for an Arctic climate (for example, Arctic Diesel 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 additive "DEUTZ FlowBoost" is recommended here in the prescribed dosage.

– TR 0199-99-01210
DEUTZ fuel additive
(InSyPro®/StartBoost/FlowBoost)

Non-road fuels and light heating oils

In some European countries, non-road fuels are defined with the same properties as diesel fuel according to EN 590, but are taxed differently than diesel fuels. As a rule, these fuels can be identified by a coloured marker.

In Germany, only the use of heating oil in beneficiary plants (electricity generation) is possible, provided that the conditions of the Energy Duty Act (§3) are met.

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

- For all non-road engines operated in Europe outside of Germany, light heating oils or non-road fuels may only be used if they are comparable with the specification according to Appendix 6, e.g. in France GNR (Gazole non Routier), and in Great Britain non-road fuel as per BS 2869:2017.

  The density of the fuel must be a maximum of 0.860 g/cm^3.
- 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), as well as the use of the fuel additive “DEUTZ StartBoost” in the prescribed dosage. As the heating oils named may contain sulphur content of up to max. 50 mg/kg, use is restricted to engines without exhaust gas after-treatment if the supplier cannot guarantee sulphur-free goods.

– TR 0199-99-01210
DEUTZ fuel additive
(InSyPro®/StartBoost/FlowBoost)

Fuel	Specifications
Non-road diesel fuel for Europe	Appendix 6
DIN 51603-1 low sulphur	Appendix 7

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 8
ISO 8217 DMA (restriction: sulphur content max. 1.0 %(m/m))	
NATO F-75	Specifications available on request
NATO F-76	

Released engines

- The releases only apply to the following engines:
  – 413/513/912/913/914M
  – 1011/2011
  – 1013/1013M
  – 1015/1015M/2015M

Basic conditions to be observed

- At a density >860 kg/m^3 at 15 °C, return blocking of the engine power by authorised DEUTZ dealers is necessary.
- The possible high sulphur content ≥ 0.2 %(m/m) requires a shorter lubricating oil change interval. Fuels with a sulphur content > 1.0 %(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 mg/kg or > 500 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 possible installation of an additional fuel filter with a water trap to avoid biological contamination in particular.

Jet fuels

Releases are exclusively restricted to official and special vehicles.

The following jet fuels can be used:

Kerosene fuel	Specifications
NATO designations: F-34, F-35, F-44, F-63 (Kerosene with lubrication additive), F-65 (1:1 mixture of F-54 and F-34/F-35)	Specifications available on request
US military designations: JP-5, JP-8	
Civil aviation: Jet A / Jet A-1	

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

For further releases of the current engine series for special application in official and special vehicles, please query at the head office.

Basic conditions to be observed

- 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 % (common rail injection) and 10 % (mechanical injection) 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.
- Jet fuels can be mixed together and with diesel fuel.

Synthetic and paraffinic fuels

These fuels are produced by Fischer-Tropsch synthesis using catalytic hydrogenation.

Production from:

- Natural gas

  (GtL = Gas to Liquid)

- Biomass
  (BtL = Biomass to Liquid)
- Vegetable oils/waste fats and oily residues not required for agriculture and the food industry
  (HVO = Hydrogenated/Hydrotreated Vegetable Oils)

Another option is to produce paraffinic diesel as an eFuel or reFuel using the Power-to-Liquid (PtL) process. The starting point here is the production of hydrogen using electrolysis. In an additional step, the hydrogen can be processed with carbon monoxide to form a synthesis gas via the Fischer-Tropsch process to produce a synthetic diesel. The carbon monoxide is obtained from carbon dioxide (CO_2) from industrial processes, biogas or from the air.

The provision of e-diesel using renewable energy will ensure more environmentally-friendly and CO_2-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 9

They also fulfil the American diesel fuel standard ASTM D975 1-D/2-D – S15 and, apart from the density, the European diesel fuel standard EN 590 as well.

They differ from diesel fuel as follows:

- Chemical composition
  - Pure paraffin / ISO paraffin
  - No aromatics
  - No carbon double bonds
- High cetane 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

Released engines

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

- Engines without exhaust gas after-treatment
  - 912/913/914/914M (no turbulence-chamber engines)
  - 2011
  - 1012/2012/1013/1013M/2013
  - 1015/1015M/2015/2015M
  - TCD 2012 2V/4V
  - TCD 2013 2V/4V
- Engines without exhaust gas after-treatment (EDG engines) and engines with exhaust gas after-treatment (DOC / DPF / SCR) of emission stages EU Stage III B / EU Stage IV, or US EPA Tier 4 interim / US EPA Tier 4 final respectively

Engines with exhaust gas after-treatment with active regeneration (combustion) of emission stage EU Stage IIIB / US EPA Tier 4 interim are excluded from this release.

  - D 2.2/TD 2.2/TCD 2.2
  - 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 V6/TCD 16.0 V8
  - TCD 9.0 L4/TCD 12.0 L6/TCD 13.5 L6/TCD 18.0 L6 (US EPA Tier 4 final)
- Engines with exhaust gas after-treatment (DOC / DPF / SCR) of emission stage EU Stage V
  - D 2.2/TD 2.2/TCD 2.2
  - 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 V6/TCD 16.0 V8
- The following commercial vehicle engines of emission stages EURO IV and V are also released:
  - TCD 2013 4V

It is a known fact that fuel leaks may occur in older 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.

All engine series 2.2/ 2.9/ 3.6/ 4.1/ 6.1/ 7.8/12.0V/16.0V/9.0/12.0L/13.5/18.0 have resistant elastomers installed.

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 a 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. The use of different vegetable oils such as soy bean oil, palm oil, rapeseed oil, sunflower oil or animal fats, used vegetable oils and used cooking fats as well as used cooking oils (UCOME = Used Cooking Oil Methyl Esther) is possible.

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)).

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, as a rule, 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 (B100)	Appendix 10
Biodiesel blends according to EN 16709 - High Fame Fuels (B20 and B30)	Appendix 11 Appendix 12
Biodiesel blend according to EN 16734 (B10)	Appendix 13
US biodiesel according to ASTM D6751 (B100) (only for biodiesel blends with diesel fuel > 20 %(V/V))	Appendix 14
US biodiesel blends according to ASTM D7467 (only for biodiesel blends with diesel fuel of 6-20 %(V/V))	Appendix 15

Biofuels in other countries

The table in appendix 16 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 16

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 (B100)							
	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 permissible for biodiesel blends with diesel fuel > 20 % (V/V) for engines in underground 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 biofuels released by DEUTZ Minimum requirement according to appendix 16		
(1)	(2)	(3)	(4)	(5)	(6)	Series	
x	x	x		x	x	413/513	
x	x	x		x	x	912/913/914/914M	
x	x	x		x	x	1011/2011	
x	x	x		x	x	1012/1013/2012/2013/1013M/2015M	
x	x	x	x[1]	x	x	1015 No flame start system	
x	x	x	x	x	x	TCD 2012 2V/4V	
x	x	x	x	x	x	TCD 2013 2V/4V	
x	x	x		x		TCD 2013 4V (Truck)	
x	x	x	x[1]	x	x	TCD 2015	
				x	x	D/TD/TCD 2.2	Emission downgrade engines
				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	

* 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)

x[1] maximum B50

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 (B100)						
	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 permissible for biodiesel blends with diesel fuel > 20 % (V/V) for engines in underground 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 biofuels released by DEUTZ Minimum requirement according to appendix 16	
(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: – 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 (B100)						
	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 permissible for biodiesel blends with diesel fuel > 20 % (V/V) for engines in underground 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 biofuels released by DEUTZ Minimum requirement according to appendix 16	
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**Series**
				x		D/TD/TCD 2.2
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
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) x[1] after 3000 h x[2] after 4500 h						

T3: Biodiesel releases

Engines with exhaust gas after-treatment
emission stages: EU Stage V

Biodiesel according to EN 14214 (B100)						
	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 permissible for biodiesel blends with diesel fuel > 20 % (V/V) for engines in underground 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 biofuels released by DEUTZ Minimum requirement according to appendix 16	
(1)	(2)	(3)	(4)	(5)	(6)	Series
	x	x				D/TD/TCD 2.2
	x	x				TD/TCD 2.9
	x	x				TD/TCD 3.6 (Only industrial engine applications)
	x	x				TCD 12.0 V6 / TCD 16.0 V8

T4: 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.
- Engines are exempted from applications if they fall under the "special services” class (for example, engines used in combined heat and power plants).
- 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 fuel-carrying parts which are installed later (by OEM or end customers, e.g. fuel pre-filters 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 biodiesel used and to improve storage behaviour and reduce deposits and clogging in the injection system, it is recommended to use the DEUTZ additive "DEUTZ Clean-Diesel InSyPro®" in the recommended dosage.

– TR 0199-99-01210
DEUTZ fuel additive
(InSyPro®/StartBoost/FlowBoost)

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 the use of 100 % (V/V) rapeseed oil (refined or cold pressed) according to DIN 51605 (appendix 17) and biodiesel according to EN 14214 (appendix 10) or a biodiesel blend according to EN 16709 (appendix 11 and appendix 12) and EN 16734 (appendix 13).

Fuel	Specifications
Rapeseed oil fuel according to DIN 51605	Appendix 17

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. If in doubt, the quality can be verified by an analysis at a laboratory accredited according to ISO 17025.
- 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 rapeseed oil used and to improve the storage behaviour and reduce deposits and clogging in the injection system, it is recommended to use the DEUTZ additive "DEUTZ Clean-Diesel InSyPro®" in the recommended dosage.

– TR 0199-99-01210
DEUTZ fuel additive
(InSyPro®/StartBoost/FlowBoost)

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. If a bacterial infestation occurs, a bactericide should be used by a specialised firm.

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 biocides

  for example:

  – Grotamar® 82

    Vink Chemicals GmbH & Co. KG
    Eichenhöhe 29
    21255 Kakenstorf
    +49 4186 - 88 797 0
    Email: OilfieldFuel@vink-chemicals.com

  – Lubrizol™ 8417B (Lubrizol Corporation)

Biocides may only be used if the fuel system and the storage tank are already infested with micro-organisms. The biocide must be dosed according to the manufacturer's specifications and carried out by specialised personnel.

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

The use is restricted exclusively to eliminating microbial contamination. Prophylactic use is not permissible.

- In suspected cases, biological contamination can be analysed according to DIN 51441 (Determination of the microbial colony number in petroleum products with a boiling range below 400 °C) or according to ASTM D 7978 (Standard Test Method for Determination of the Viable Aerobic Microbial Content of Fuels and Associated Water-Thixotropic Gel Culture Method) by laboratories certified according to ISO 17025.
- Alternatively, appropriate quick check kits are 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 5-12 (Petroleum products - Guidelines for good housekeeping - Part 1: Part 1: Automotive diesel fuels) and CEN/TR 15367-3 (Petroleum products - Guidelines for good housekeeping - Part 3: Prevention of cross contamination).

Fuel additives

Only the following additives are suitable for use in DEUTZ engines in the special applications intended for them:

- DEUTZ InSyPro®
- DEUTZ StartBoost
- DEUTZ FlowBoost

Information on use and dosing:

– TR 0199-99-01210
DEUTZ fuel additive
(InSyPro®/StartBoost/FlowBoost)

Organometallic additives (for example ferrocene or satacene) for the catalytic regeneration of particulate filters are generally prohibited in DEUTZ engines with exhaust after-treatment systems.

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.

EU fuel labelling

EU Directive 2014/94/EU (Directive of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure) stipulates uniform standards for an infrastructure for alternative fuels in Europe.

This is intended to facilitate the introduction of such fuels. Moreover, consumers and vehicle operators will be able to find the same conditions across the border as in their home country. Since 12.10.2018, the directive has provided for a mandatory, EU-wide introduction of a new, uniform fuel labelling system to ensure that consumers can clearly identify which fuels are compatible with their engines.

In Germany, the EU Directive has been transposed into national law within the framework of the 10th BImSchV ("Ordinance on the Quality and Labelling of Fuels").

It is mandatory to attach the new labelling with its various geometric shapes and symbols:

- in public petrol stations on the petrol pump and on the pump nozzle
- on all fuel filler caps
- in manuals of newly produced vehicles

Further information

– EN 16942
Fuels – Identification of vehicle compatibility – Graphical representation of consumer information

– www.fuel-identifiers.eu/
Information for consumers and manufacturers in 18 languages

Labelling for diesel fuel

B7 Diesel fuel according to EN 590
(Fatty acid methyl ester content maximum 7 % by volume)

B10 Fuel according to EN 16734
(Fatty acid methyl ester content maximum 10 % by volume)

B20 Fuel according to EN 16709
(Fatty acid methyl ester content maximum 20 % by volume)

B30 Fuel according to EN 16709
(Fatty acid methyl ester content maximum 30 % by volume)

B100 Fatty acid methyl ester (FAME) according to EN 14214 (Biodiesel)

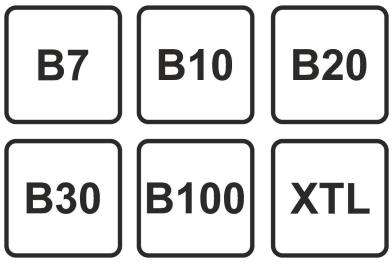
XTL Paraffinic diesel fuel according to EN 15940

Example of a label

TCD 4.1 L4 (Diesel engine, emission stage EU Stage IV)

Released fuels:

- Diesel fuel according to EN 590 (B7)
- Fuel with FAME content up to 10 % according to EN 16734 (B10)
- Fuel with FAME content up to 30 % according to EN 16709 (B20 and B30)
- Biodiesel (FAME) according to EN 14214 (B100)
- Paraffinic diesel fuel according to EN 15940 (XTL)



Contact

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

e-mail: lubricants.de@deutz.com

or
DEUTZ Ticket System (DTS): https://www.dts-deutz.com (for registered users only)

or
Email: service-kompaktmotoren.de@deutz.com

For the America region:
e-mail: service.usa@deutz.com

For the Asia region:
e-mail: dapservice@deutz.com

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Appendices

The date of issue of the fuel specifications refers to the national translation of the EN into DIN EN or of the ISO into DIN ISO.

Appendix 1

Fuel specification
Diesel fuel according to EN 590
October 2017 edition

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. max.	820 845	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
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. max.	2.0 4.5	EN ISO 3104
Distillation – starting at 250 °C – starting at 350 °C – 95 vol.% starting at	 %(V/V) %(V/V) °C	 max. min. max.	 65 85 360	EN ISO 3405 EN ISO 3924
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) – 15.04. - 30.09. – 01.10. - 15.11. – 16.11. - 28.02. (in leap years 29.02.) – 01.03. - 14.04.	 °C °C °C °C	 max. max. max. max.	 0 -10 -20 -10	EN 116 EN 16329
* specifications apply for Germany. National regulations may deviate.				

Appendix 2

Fuel specification
US diesel fuel according to ASTM D975b:2020

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 °C	– max.	– 288	min. max.	282 338	ASTM D86
Kinematic viscosity at 40 °C	mm^2/s	min. max.	1.3 2.4	min. max.	1.9 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
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 3

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

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	
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 content (FAME)	%(m/m)	max.	5					–

Appendix 4

Fuel specification
China diesel fuel according to GB 19147-2016

Properties	Units		Limit values						Test method
			Fuel grade						
			No. 5	No. 0	No. -10	No. -20	No. -35	No. -50	
Oxidation stability	mg/100 ml	max.	2.5						SH/T 0175
Sulphur content	mg/kg	max.	10						SH/T 0689
Acid number	mg KOH/100 ml	max.	7						GB/T 258
Coke residue (from 10 % distillation residue)	%(m/m)	max.	0.3						GB/T 17144
Ash content	%(m/m)	max.	0.01						GB/T 508
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	max.	1						GB/T 5096
Water content	%(V/V)	max.	Traces						GB/T 260
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	max.	460						SH/T 0765
Polycyclic aromatic hydrocarbons	%(m/m)	max.	11						SH/T 0806
Total contamination	mg/kg	max.	24						GB/T 33400
Kinematic viscosity at 20 °C	mm^2/s		3.0 – 8.0		2.5 – 8.0		1.8 – 7.0		GB/T 265
Pour Point	°C	max.	5	0	-10	-20	-35	-50	GB/T 510
Limit of filtrability (CFPP)	°C	max.	8	4	-5	-14	-29	-44	SH/T 0248
Flashpoint	°C	min.	60			50	45		GB/T 261
Cetane number		min.	51			49	47		GB/T 386

Fuel specification
China diesel fuel according to GB 19147-2016

Properties	Units		Limit values Fuel grade No. 5	No. 0	No. -10	No. -20	No. -35	No. -50	Test method
Cetane index		min.	46			46	43		SH/T 0694
Distillation – starting at 300 °C – starting at 355 °C – 95 vol.% starting at	 %(V/V) %(V/V) °C	 max. max. max.	50 90 365						GB/T 6536
Density at 20 °C	kg/m ^{3}		810 – 850			790 – 840			GB/T 1884 GB/T 1885
Fatty Acid Methyl Ester content (FAME)	%(V/V)	max.	1.0						NB/SH/T 0916

Appendix 5

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

Parameter	Basic condition	Units	DEUTZ requirement min.	max.	Test method
Density at 15 °C	–	kg/m ^{3}	820 [1]	860	ISO 3675 ISO 12185
Cetane number	Ambient temperatures > 0 °C	–	40.0	–	ISO 5156 ISO 15195 ASTM D613 ASTM D6890
	Ambient temperatures ≤ 0 °C		45.0	–	
Kinematic viscosity at 40 °C	Ambient temperatures > 0 °C	mm ^{2}/s	1.8	4.5	ISO 3104 ASTM D44
	Ambient temperatures < 0 °C		1.2	4.0	
Cloud Point	–	°C	at least 5 °C lower than the ambient temperature		ISO 3015

[1] For Arctic diesel fuels, the lower density limit is 800 kg/m ^{3} at 15 °C.

[2] At sulphur contents > 2000 mg/kg, the lubricating oil change intervals must be halved.

[3] At dirt contents > 24 mg/kg, fuel filters with a higher dirt capacity and very high efficiency must be used.

[4] Biodiesel content is based on national regulations and may be a little higher. In individual cases, the head office must be consulted.

[5] Only applies to emission downgrade engines of the series 9.0 / 12.0 L / 13.5 / 18.0

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

Parameter	Basic condition	Units	DEUTZ requirement min.	DEUTZ requirement max.	Test method
Sulphur content	Engines without exhaust gas after-treatment [2]	%(m/m)	–	1.0	ISO 20846 ISO 20847 ASTM D3605 ASTM D1552
	Engines with externally cooled exhaust gas recirculation and without exhaust gas after-treatment	mg/kg	–	500	
	TCD 9.0 / 12.0 L / 13.5 / 18.0 without exhaust gas after-treatment	mg/kg	–	2000	
	Engines with exhaust gas after-treatment	mg/kg	–	15	
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	–	µm	–	520 460 [5]	ISO 12156-1 ASTM D6079
50 %V/V boiling temperature	–	°C	–	282	ISO 3405 ASTM D86
90 %V/V boiling temperature			–	360	
Coke residue (from 10 % distillation residue)	–	%(m/m)	–	0.35	ASTM D524
Ash content	–	%(m/m)	–	0.01	ISO 6245 ASTM D482
Water content	–	mg/kg	–	200	ISO 12937
Total contamination	–	mg/kg	–	24 [3]	EN 12662
Alternative to water content and total contamination: Water and sediments	–	%(V/V)	–	0.05	ASTM D473
Corrosion effect on copper (3 h at 50 °C)	–	Degree of corrosion	–	3	ISO 2160 ASTM D130
Fatty Acid Methyl Ester content (FAME)	–	%(V/V)	–	7 [4]	EN 14078

[1] For Arctic diesel fuels, the lower density limit is 800 kg/m [3] at 15 °C.

[2] At sulphur contents > 2000 mg/kg, the lubricating oil change intervals must be halved.

[3] At dirt contents > 24 mg/kg, fuel filters with a higher dirt capacity and very high efficiency must be used.

[4] Biodiesel content is based on national regulations and may be a little higher. In individual cases, the head office must be consulted.

[5] Only applies to emission downgrade engines of the series 9.0 / 12.0 L / 13.5 / 18.0

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
Non-road diesel fuel for Europe

Properties	Units	Limit values min.	Limit values max.	Test method
Cetane number	–	45.0	–	EN ISO 5165
Density at 15 °C	kg/m^3	820	845	EN ISO 3675
Distillation – starting at 250 °C – starting at 350 °C	 %(V/V) %(V/V)	 – 85	 65 –	EN ISO 3405
Flashpoint	°C	55	–	EN 22719
Limit of filtrability (CFPP) – 16.03. - 30.09. – 01.10. - 14.11. – 15.11. - 15.03.	 °C °C °C	 – – –	 -5 -10 -15	EN 116
Viscosity 40 °C	mm^2/s	2.0	5.0	EN ISO 3104
Polycyclic aromatic hydrocarbons	%(m/m)	2.0	6.0	IP 391
Sulphur content	mg/kg	–	10	ASTM D5453
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1		EN ISO 2160
Coke residue (from 10 % distillation residue)	%(m/m)	–	0.30	EN ISO 10370
Ash content	%(m/m)	–	0.01	EN ISO 6245
Total contamination	mg/kg	–	24	EN 12662
Water content	%(m/m)	–	0.02	EN ISO 12937
Acid number	mg KOH/g	–	0.10	ASTM D974
Oxidation stability	mg/ml	–	0.025	EN ISO 12205
Oxidation stability at 110 °C	hours	20	–	EN 15751
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	–	460	CEC F-06-A-96
Fatty Acid Methyl Ester content (FAME)	%(V/V)	–	7	EN 14078

Appendix 7

Fuel specification
Light heating oil EL according to DIN 51603-1, low sulphur
September 2020 edition

Properties	Units	Limit values		Test method
Density at 15 °C	kg/m^3	min. max.	815 860	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 Total evaporated volume parts – up to 250 ℃ – up to 350 ℃	 %(V/V) %(V/V)	 max. min.	 65 85	EN ISO 3405
Cloud Point	°C	max.	3	EN 23015
Limit of filtrability (CFPP) depending on the cloud point – at cloud point = 3 ℃ – at cloud point = 2 ℃ – at cloud point < 1 °C	 °C °C °C	 max. max. max.	 -12 -11 -10	EN 116
Coke residue (from 10 % distillation residue)	%(m/m)	max.	0.3	EN ISO 10370 DIN 51551-1
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 8

Fuel specification
Marine distillate fuel (marine fuels) according to ISO 8217
October 2018 edition

Properties	Units	Limit values	Category ISO-F		Test method
			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
Coke residue (from 10 % distillation residue)	%(m/m)	max.	0.30	0.30	ISO 10370
Cloud Point – Winter quality – Summer quality	 °C °C	 max. max.	 -16 -16	 Specific-ation –	ISO 3015
Limit of filtrability (CFPP) – Winter quality – Summer quality	 °C °C	 max. max.	 – –	 Specific-ation –	IP 309 or IP 612
Pour Point – Winter quality – Summer quality	 °C °C	 max. max.	 – –	 -6 0	ISO 3016
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

* At a density >860 kg/m^3 at 15 °C, return blocking of the engine power by authorised DEUTZ dealers is necessary.
** Observe DEUTZ restriction / shortened lubricating oil change interval

Appendix 9

Fuel specification
Paraffinic diesel fuel from synthesis or hydrotreatment according to EN 15940
October 2019 edition

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 40 °C	mm^2/s	2.00	4.50	2.00	4.50	EN ISO 3104
Distillation – starting at 250 °C – starting at 350 °C – 95 %(m/m) collected at	 %(m/m) %(m/m) °C	 65 85 –	 – – 360	 65 85 –	 – – 360	 EN ISO 3405 EN SIO 3924
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	–	460	–	460	EN ISO 12156-1
Fatty Acid Methyl Ester content (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
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) – 15.04. - 30.09. – 01.10. - 15.11. – 16.11. - 28.02. (in leap years 29.02.) – 01.03. - 14.04.	 °C °C °C °C	 – – – –	 0 -10 -20 -10	 – – – –	 0 -10 -20 -10	EN 116 EN 16329
* specifications apply for Germany. National regulations may deviate.						

Appendix 10

Fuel specification
Fatty acid methyl esters (FAME) for use in diesel engines and as heating oil in accordance with EN 14214
May 2019 edition

Properties	Units	Limit values		Test method
Fatty Acid Methyl Ester content (FAME)	%(m/m)	min.	96.5	EN 14103
Density at 15 °C	kg/m^3	min. max.	860 900	EN ISO 3675 EN ISO 12185
Viscosity 40 °C	mm^2/s	min. max.	3.5 5.0	EN ISO 3104
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
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) – 15.04. - 30.09. – 01.10. - 15.11. – 16.11. - 28.02. (in leap years 29.02.)	 °C °C °C	 max. max. max.	 0 -10 -20	EN 116 EN 16329
* specifications apply for Germany. National regulations may deviate.				

Fuel specification
Fatty acid methyl esters (FAME) for use in diesel engines and as heating oil in accordance with EN 14214
May 2019 edition

Properties	Units	Limit values	Test method
– 01.03. - 14.04.	°C	max. -10	
* specifications apply for Germany. National regulations may deviate.			

Appendix 11

Fuel specification
Fuel with high FAME content (B20) according to EN 16709
February 2019 edition

Properties	Units	Limit values	Test method
Fatty Acid Methyl Ester content (FAME)	%(V/V)	min. 14.0 max. 20.0	EN 14078
Cetane number	–	min. 51	EN ISO 5165 EN 15195 EN 16144 EN 16715 EN 16906
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 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
Total contamination	mg/kg	max. 24	EN 12662
Oxidation stability	hours	min. 20	EN 15751
Distillation			EN ISO 3405
– starting at 250 °C	%(V/V)	max. 65	EN ISO 3924
– starting 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 12

Fuel specification
Fuel with high FAME content (B30) according to EN 16709
February 2019 edition

Properties	Units	Limit values		Test method
Fatty Acid Methyl Ester content (FAME)	%(V/V)	min. max.	24.0 30.0	EN 14078
Cetane number	–	min.	51	EN ISO 5165 EN 15195 EN 16144 EN 16715 EN 16906
Density at 15 °C	kg/m^3	min. max.	825 865	EN ISO 3675 EN ISO 12185
Flashpoint	°C	min.	55.0	EN ISO 2719
Viscosity 40 °C	mm^2/s	min. max.	2.00 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 – starting at 250 °C – starting at 350 °C – 95 vol.% starting at	 %(V/V) %(V/V) °C	 max. min. max.	 65 85 360	EN ISO 3405 EN ISO 3924
Limit of filtrability (CFPP) – 15.04. - 30.09. – 01.10. - 15.11. – 16.11. - 28.02. (in leap years 29.02.) – 01.03. - 14.04.	 °C °C °C °C	 max. max. max. max.	 0 -10 -20 -10	EN 116 EN 16329
* specifications apply for Germany. National regulations may deviate.				

Appendix 13

Fuel specification
Fuel with FAME content (B10) according to EN 16734
February 2019 edition

Properties	Units	Limit values		Test method
Fatty Acid Methyl Ester content (FAME)	%(V/V)	max.	10.0	EN 14078
Cetane number	–	min.	51	EN ISO 5165 EN 15195 EN 16144 EN 16715 EN 16906
Cetane index	–	min.	46	EN ISO 4264
Density at 15 °C	kg/m^3	min. max.	820 845	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 40 °C	mm^2/s	min. max.	2.0 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 – starting at 250 °C – starting at 350 °C – 95 vol.% starting at	 %(V/V) %(V/V) °C	 max. min. max.	 65 85 360	EN ISO 3405 EN ISO 3924
Limit of filtrability* (CFPP) – 15.04. - 30.09. – 01.10. - 15.11. – 16.11. - 28.02. (in leap years 29.02.) – 01.03. - 14.04.	 °C °C °C °C	 max. max. max. max.	 0 -10 -20 -10	EN 116 EN 16329
* specifications apply for Germany. National regulations may deviate.				

Appendix 14

Fuel specification
US biodiesel according to ASTM D6751a:2020 (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 15

Fuel specification
US biodiesel blends according to ASTM D7467a:2020 (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
* Country-dependent and dependent on the type of application in cold seasons.			

Fuel specification
US biodiesel blends according to ASTM D7467a:2020 (B6 to B20)

Properties	Units	Limit values	Test method
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 16

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

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
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
Cloud Point*	°C	at least 5 °C lower than the ambient temperature	ISO 3015
* 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 17

Fuel specification
Rapeseed oil fuel according to DIN 51605
November 2020 edition

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 max. 925	EN ISO 3675 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
Willingness to ignite	–	min. 40	EN 15195
Iodine number	g Iodine/100 g	max. 125	EN ISO 3961

Fuel specification
Rapeseed oil fuel according to DIN 51605
November 2020 edition

Properties	Units	Limit values		Test method
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 18

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. 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). In individual nations in South America, Asia and some US states, higher biodiesel percentages of up to 20 or 30 %(V/V) are also possible.

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 ℃ 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 1 % 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 mm^2/s = 1 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.

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