

## Paraffinic diesel fuel according to EN 15940

Standards define paraffinic diesel fuels as being fuels produced by synthesis or hydrogenation processes. They are specified in the EN 15940 standard.

### Synthesis

In this case, the term synthesis is used to denote the Fischer-Tropsch reaction. These fuels are therefore also often referred to as Fischer-Tropsch fuels or also XtL (X to Liquid), whereby "X" stands for the type of initial feedstock. Such fuels are produced by first generating a mixture of carbon monoxide and hydrogen, referred to as synthesis gas, from the initial feedstock. This is then used to create the paraffinic fuel via Fischer-Tropsch synthesis by means of chain growth.

### Hydrogenation

Hydrogenation is the chemical reaction of the feedstock with hydrogen. The initial feedstock used are vegetable oils/waste fats and waste materials containing oil that are not in competition with foodstuff production. This fuel is marketed as an HVO = Hydrotreated Vegetable Oil.

Depending on the initial feedstock, paraffinic fuels are designated, for example, as follows:

- HVO = Hydrotreated Vegetable Oil, initial feedstock: Biomass
- GtL = Gas to Liquid, initial feedstock: Natural gas, biogas
- BtL = Biomass to Liquid, initial feedstock: Biomass

As a result of the production process, paraffinic fuels consist almost entirely of linear or branched hydrocarbon chains, so-called alkanes. They do not contain any sulfur and are almost free of aromatics. Due to their chemical composition, paraffinic fuels have different properties to fossil diesel fuels in terms of higher ignitability and lower density. The result is an overall reduction in untreated emissions.

EN 590 specifies that fatty acid methyl ester (FAME as per EN 14214) can be blended into paraffinic diesel fuel as per EN 15940 by up to 7% by volume.

Paraffinic diesel fuels are specified in ASTM D975 (Grade 1-D and Grade 2-D, S15) in the U.S., just like fossil diesel fuels. This is possible as this standard does not specify any limit value for density, in contrast to EN 590. These paraffinic diesel fuels can also be used provided that they comply with the fuel values listed in table (→ Page 94). In the U.S., paraffinic diesel fuels are often referred to as "R99" fuels or "renewables".

The quality of the fuel is very important for satisfactory engine performance, long engine service life and acceptable exhaust emission levels. Paraffinic fuels must therefore meet the following fuel specifications.

### Mandatory fuel specifications

		Test methods		Limit values
		ASTM		
Composition				The diesel fuel must be free of inorganic acids, visible water, solid foreign matter, and chlorine compounds.
Total contamination (= fuel-insoluble ingredients)	Max.	D6217	EN 12662	24 mg/kg
Density at 15 °C	Min.	D1298	EN ISO 3675	0.765 g/ml <sup>1)</sup>
	Max.	D4052	EN ISO 12185	0.860 g/ml
API gravity at 60 °F	Min.	D287		53
	Max.			33
Viscosity at 40 °C	Min.	D445	EN ISO 3104	1.5 mm <sup>2</sup> /s
	Max.			4.5 mm <sup>2</sup> /s

TMM-01.0000071312 - 009

		Test methods		Limit values
		ASTM		
Flashpoint (closed crucible)	Greater	D93	DIN EN ISO 2719	55 °C (60 °C for SOLAS) <sup>2)</sup>
Boiling curve:		D86	EN 17306	
– Initial boiling point				160 to 220 °C
– Volume share at 250 °C	Max.			65% by volume
– Volume share at 350 °C	Min.			85% by volume
– Residue and loss	Max.			3% by volume
Fatty acid methyl ester content (FAME) (“Biodiesel”)	Max.		EN 14078 Internal mtu procedure	7.0% by volume
Water content: (absolute, no free water)	Max.	D6304	EN ISO 12937	200 mg/kg
Carbon residue from 10% distillation residue	Max.	D189	EN ISO 10370	0.30% by weight
Oxide ash:		D482	EN ISO 6245	0.01% by weight (100 mg/kg)
– Engines without exhaust gas aftertreatment and without exhaust gas recirculation	Max.			
Sulfur content	Max.	D5453 D2622	EN ISO 20848 EN ISO 20884	0.0015% by weight (15 mg/kg) <sup>3)</sup>
Cetane number	Min. Max.	D613	EN ISO 5165 EN ISO 15195	45 80 <sup>4)</sup>
Cetane index	Min.			D976
Copper corrosion 3 hrs. at 50 °C	Max. degree of corrosion	D130	EN ISO 2160	1 a
Oxidation stability (Rancimat) <sup>5)</sup>	Min.		EN 15751	20 hours
Oxidation stability <sup>6)</sup>	Max.	D2274	EN ISO 12205	25 g/m <sup>3</sup>
Lubricity at 60 °C (HFRR value)	Max.	D6079	EN ISO 12156-1	400 µm
Neutralization number	Max.	D974		0.2 mgKOH/g

Table 65:

- 1) = May result in reduced power on engines featuring unit-pump injection systems (PLD).
- 2) = For Marine applications, a min. flashpoint of 60 °C (SOLAS = Safety of life at sea) applies.
- 3) = Note: 1% by weight = 10000 mg/kg = 10000 ppm.
- 4) = Higher cetane number possible upon request from Rolls-Royce Solutions GmbH.
- 5) = Relevant for diesel fuel with a FAME content of  $\geq 2\%$  by volume
- 6) = Relevant for diesel fuel with a FAME content of  $< 2\%$  by volume

Compliance with the requirements stipulated in the tables “Cylinder head TBO” and “Series-related injection/and exhaust gas aftertreatment systems (EGAT)” (→ Page 43) is mandatory in regard of winter operation and purity requirements for the diesel fuel.

Paraffinic diesel fuels as per EN 15940 or ASTM D975 (Grade 1-D and Grade 2-D, S 15) have been approved for the following Series provided that they comply with the characteristic values specified in the table (→ Table 66):

Engine		Safety <sup>1)</sup>	Emission stage <sup>2)</sup>				Comments
Series	Application		Non-cert	EPA	EU	IMO	
1600	Gx0	X	X	T2, T3	IIIA		EPA T3: only 10V1600G70S EU IIIA: only 10V engines
1600	Gx1	X	X	T2			
2000	Mx2, Mx3, Mx4	X	X	T2		T2	
2000	Mx6	X		T3c T3r	*	T2	T3c: EPA Tier 3 for commercial use T3r: EPA Tier 3 for recreational use * = EU Recr. Craft Dir. 2013/53/EU + UK
4000	Gx3	X	X	T2			
4000	Gx4	X	X	T2			
4000	Mx0, Mx1	X	X	T2	ZKR2	T1 T2	
4000	Mx3	X	X	T2	IIIA	T2	EU IIIA: M53x/M63x only ZKR2: M23x/M33x only
4000	Mx4	X	X	T3	IIIA	T2	EU IIIA: M54R only
4000	Mx5	X	X	T4		T2 T3	
4000	Px3	X	X	T2		T2	
4000	Cx1	X	X	T1**			** = Compliant <sup>3)</sup>
4000	Cx2	X	X	T1**			** = Compliant <sup>3)</sup>
4000	Cx3	X	X	T2**			** = Compliant <sup>3)</sup>
4000	Cx5	X	X	T4	V		
4000	Sx1	X	X	T1**			
4000	Sx3	X	X	T2**			** = Compliant <sup>3)</sup>
4000	Tx4	X	X	T4i**			** = Compliant <sup>3)</sup>
4000	Tx5	X	X	T4			
4000	Rx1	X	X <sup>4)</sup>				
4000	Rx3	X	X <sup>4)</sup>		IIIA		
4000	Rx4	X			IIIB, V		

Table 66:

<sup>1)</sup> = The product safety of the engine in terms of danger for life and limb is guaranteed with the use of these fuels.

<sup>2)</sup> = The limit values of the respective emission level are respected when using these fuels.

<sup>3)</sup> = Compliant: Respects emission limits, no certificate available.

<sup>4)</sup> = Includes approval for UIC engines (IRS60623/IRS60624), EN15940 does not meet the requirements of the UIC reference fuel.

TMA-01:0000071312 - 009

## Important

Further project-specific approvals are possible upon request from Rolls-Royce Solutions GmbH.

### Effects of paraffinic diesel fuels on elastomer components

Paraffinic diesel fuels are compatible with conventional elastomer materials such as NBR (Nitrile Butadiene Rubber) or FKM (fluoro-rubber). Because they are free of aromatics, they are less susceptible to swelling (above all, NBR gaskets) compared to fossil diesel fuels that contain aromatics. For this reason, the possibility of leakages when transitioning from fossil diesel fuels to paraffinic diesel fuels cannot be completely excluded.

### Procedure for changing over from fossil to paraffinic diesel fuels:

A change-over is possible without any problems. RRS recommends routine inspection of the seals to verify leak-tightness in the first 4 weeks after switching to paraffinic diesel.

### Notes on operation with water separators

Paraffinic diesel fuel has a greater tendency to discharge free water into water separators compared with conventional fossil diesel fuel. Slightly higher water discharge in water separators in comparison with fossil diesel fuel is normal.

### Blending paraffinic diesel fuels with conventional fossil diesel fuels:

Paraffinic diesel fuels are so-called “drop-in” fuels.

This means that the end customer can mix paraffinic diesel fuel with conventional fossil fuels in any ratio without having to make any adjustments to the engine or fuel system.

This also means that the end customer can fill up with both paraffinic and conventional fossil diesel fuels according to the tables “Mandatory fuel specifications (not applicable to Series 4000Mx5 IMO II and IMO III)” and “Mandatory fuel values for Series 4000Mx5 IMO II and IMO III (→ Page 43) without having to empty/clean the tank first.

“Premium diesel fuels” which comply with EN 590 and also reduce CO<sub>2</sub> emissions by around 20% are also available on the market. Paraffinic diesel fuel in accordance with EN 15940 is already added to these fuels at the manufacturer's. The amount of paraffinic diesel fuel added, however, is only high enough to ensure observance of the required minimum density limit value specified in EN 590.

## 5.2.9 Engine operation on diesel fuel with a biodiesel content of up to 30%

### Important

Project-specific approval from Rolls-Royce Solutions GmbH is possible upon request.

The term biodiesel is used for what the standards refer to as "FAME" (Fatty Acid Methyl Ester) in this case.

More information about diesel fuel containing up to 30% FAME is provided below and in the Customer Information entitled "Diesel fuel containing up to 30% FAME" (publication number A060632/..).

### Use of diesel fuel containing up to 30% FAME

Biodiesel mixtures consist of fuels which are obtained from biogenic raw materials and mixed with conventional diesel fuel. For instance, B20 denotes a mixture comprising 20% biodiesel and 80% fuel based on crude oil/mineral oil. mtu engines were not specially designed to be operated with biodiesel mixtures. For this reason, the use of biodiesel mixtures may have negative effects in terms of engine power, service and maintenance requirements, emissions and useful life.

Operators of mtu engines therefore need to be clear about the effects that biodiesel may have on their engines, and must take all of the necessary measures to ensure the reliability and safety of their engines. This chapter provides Rolls-Royce Solutions customers with important information on the use of biodiesel mixtures in mtu engines and explains the potential impact these fuels may have on the Rolls-Royce Solutions warranty. Please read this information carefully before using biodiesel mixtures in mtu engines.

#### 1. Regarding the use of approved biodiesel mixtures

At present, only biodiesel mixtures with up to 7% biodiesel (in accordance with EN 590) or 5% biodiesel (in accordance with ASTM D 975) are approved for use in the Fluids and Lubricants Specifications.

Although not currently approved in the Fluids and Lubricants Specifications, biodiesel mixtures containing up to 30% biodiesel (B30) may be used in the engines listed in section 6 below,

- PROVIDING THAT the following requirements are met:
  - The biodiesel mixtures are specified according to the following standards:
    1. 3675.K/24/DJM (standard for diesel fuel with 10% biodiesel content, i.e. B10, in Indonesia)
    2. 28.K/10/DJM.T (standard for diesel fuel with 20% biodiesel content, i.e. B20, in Indonesia)
    3. 0234.K/10/DJM.S/2019 (standard for diesel fuel with 30% biodiesel content, i.e. B30, in Indonesia)
    4. EN 16734 (European standard for diesel fuel with 10% biodiesel content, i.e. B10)
    5. EN 16709 (European standard for diesel fuel with 20% and 30% biodiesel content, i.e. B20 and B30)
    6. ASTM D7467 (US standard for diesel fuel with 6% to 20% biodiesel content, i.e. B6 - B20)
    7. The biodiesel used for mixing complies with the standards EN 14214, ASTM D 6751 or SNI 71825
    8. The distilled diesel fuel used for mixing is approved in the latest version of the Fluids and Lubricants Specifications.
    9. The operator complies with the operating requirements given in section 2 and the additional maintenance recommendations from section 5.

### Important

The provisions with regard to requirements placed on fuel may differ depending on legislation and application of the engine. The operator is responsible for ensuring that only fuels which comply with the applicable provisions are used in the engines.

TIM-01:000072504 - 010

## 2. Operating requirements for the use of diesel fuels with a biodiesel content of up to 30%

The following operating requirements must be met when biodiesel mixtures are used in mtu engines:

- a For engines used in standby gensets, an additive must be used to improve the oxidation stability of the biodiesel.
- b All engines used in fire-fighting pumps, fire-extinguishing equipment or police equipment must be thoroughly flushed with pure, biodiesel-free, high-quality distilled diesel fuel which complies with the Fluids and Lubricants Specifications each time they are operated with a biodiesel mixture. Furthermore, an additive must be used in these engines to improve the oxidation stability of the biodiesel.
- c All engines which are only used seasonally or which are not operated for extended periods between uses must be thoroughly flushed with pure, biodiesel-free, high-quality distilled diesel fuel which complies with the Fluids and Lubricants Specifications before they are decommissioned.
- d Biodiesel mixtures can not be used in engines equipped with an exhaust gas aftertreatment system (e.g. catalytic converters, particle filters (DPF) and/or systems for reducing NOx emissions, e.g. SCR systems).

## 3. Impact on the Rolls-Royce Solutions warranty

The manufacturer shall not be responsible for failures which can be attributed to the use of fuels not approved in these Fluids and Lubricants Specifications and such failures shall therefore not be covered by the Rolls-Royce Solutions warranty. Rolls-Royce Solutions shall reject all warranty claims connected to the use of biodiesel mixtures with a biodiesel content of more than 7% (in accordance with EN 590) or 5% (in accordance with ASTM D 975) if the operator is unable to prove that the operating requirements and recommendations contained in this letter were met and strictly followed. Regardless of this, Rolls-Royce Solutions shall on no account be liable for providing compensation for costs arising from the effects described below in section 4.

### Important

All properties guaranteed by Rolls-Royce Solutions in terms of assured characteristics with regard to engine power and/or operational availability only apply to the cases in which fuels approved by Rolls-Royce Solutions are used and the engine demonstrates no defects or damage arising from operation with fuels not approved in these Fluids and Lubricants Specifications.

## 4. Effects of biodiesel on engines/exclusion of liability

The biodiesel contained in biodiesel mixtures is a natural product and therefore undergoes natural aging processes. These may have a negative effect on the engines in which the biodiesel mixtures are used. The effects that biodiesel may have on engines are explained below.

**Important: THESE EFFECTS ARE NOT FAULTS CAUSED BY THE ENGINE MANUFACTURER. THEY ARE THEREFORE EXCLUDED FROM THE Rolls-Royce Solutions WARRANTY. ROLLS-ROYCE SOLUTIONS SHALL NOT ASSUME ANY LIABILITY FOR COSTS ARISING FROM THE EFFECTS DESCRIBED BELOW.**

- The formation of deposits may cause components to become “sticky”, which potentially restricts their movement. On engines with long downtimes, this can result in a situation where the engine can no longer be started. This is why additives for improving the oxidation stability of the biodiesel must be employed when biodiesel mixtures are used in standby gensets. ROLLS-ROYCE SOLUTIONS SHALL ACCEPT NO LIABILITY IN THE EVENT THAT THE ENGINE IN AN STANDBY GENSET CAN NOT BE STARTED AS A RESULT OF THE FORMATION OF DEPOSITS.
- The formation of deposits may have an adverse effect on the interaction of components inside the unit. This results in an increased risk of components failing, and even the breakdown of entire cylinders. The high operating temperatures in the surroundings encourage the formation of mineral deposits, other deposits and encrustations which may render the valve unable to correctly regulate the fuel supply. This means that it is no longer possible for the quantity of fuel required at full load to be injected into the engine, thereby reducing the maximum engine power.
- The viscosity properties of biodiesel are less favorable at low temperatures. The use of biodiesel at low temperatures may therefore cause the fuel filter to become clogged.
- On all engines, lubricating the piston skirts with oil leads to a small amount of fuel entering the engine oil. This is generally of little importance with conventional diesel fuels in accordance with these Fluids and Lubricants Specifications since the fuel evaporates quickly upon reaching the operating temperature. On the other hand, biodiesel evaporates much less effectively, with the result that more biodiesel accumulates in the oil. Aging of the biodiesel can therefore cause residues to form, filters to become clogged and ultimately cause the engine to come to a stop, resulting in significantly shorter oil change intervals.
- Compared to conventional diesel fuels according to these Fluids and Lubricants Specifications, biodiesel has a lower energy density. Operating the engine with B20 results in a power reduction of approximately 2% and an increase in fuel consumption of around 3%.
- Biodiesel contains chemical components which can interact with the sensors in the exhaust gas recirculation system in such a way that incorrect data is reported to the engine control system. This can have consequences such as engine operation being adapted to the wrong values and emissions therefore no longer complying with the applicable provisions. This is why biodiesel must not be used in engines which feature exhaust gas recirculation (EGR) and/or exhaust gas aftertreatment systems.
- Compared to conventional diesel fuels according to these Fluids and Lubricants Specifications, biodiesel has a higher water solubility, meaning that a higher proportion of water should be expected depending on the fuel temperature. This can lead to increased corrosion and faster microbe growth in the fuel system. Due to the higher proportion of water in biodiesel, reduced water separator performance must be expected.
- Biodiesel is a solvent. After switching over to a biodiesel mixture, impurities and certain deposits may become loose in the tank and lines, causing the fuel filter to be subjected to an increased accumulation of these. Biodiesel mixtures may also strip paint when they come into contact with painted surfaces.
- On engines with exhaust gas aftertreatment systems, the functioning of the catalytic converter may be impaired as biodiesel mixtures can contain a higher proportion of trace elements (e.g. calcium, magnesium, sodium, potassium and phosphorus) than conventional diesel fuels according to these Fluids and Lubricants Specifications. This means that the legally prescribed emissions limits are not complied with and the operating license becomes invalid. Furthermore, legally prescribed technologies for checking emissions on these engines (e.g. NOx monitoring diagnostics) lead to a significant decrease in engine power. The above-mentioned trace elements may also result in excess ash formation and accumulations in the soot filters and catalytic converters. Excess ash formation results in a constantly rising exhaust back pressure and can therefore cause a slow reduction in engine power.

The above-mentioned points do not constitute a complete risk assessment. Rolls-Royce Solutions is unable to assess all biodiesel variants and their long-term effects on mtu products.

TM-HD: 0000072504 - 010

## 5. Additional maintenance recommendations

The following requirements must be met to ensure the quality and operational availability of your engine:

- Select the highest possible content of distilled fuel. Only use fuels approved in these Fluids and Lubricants Specifications.
- After switching over to a biodiesel mixture, replace the fuel filters after 50 operating hours at the latest (in order to remove the impurities which become loose from the tank and lines).
- The fuel filters and fuel prefilters must be renewed every 250 operating hours.
- Install a fuel preheating system if the engine is operated at temperatures below 0 °C (32 °F). This can reduce the negative effect on the fuel supply.
- Follow the recommendations below with regard to engine oil and maintenance:
  - If biodiesel mixtures are used, the change intervals for engine oil and filters must be halved in comparison to the intervals stated in these Fluids and Lubricants Specifications.
  - The component TBO of the LP fuel pump, the O-rings in the LP fuel system as well as the valves in the fuel filter head is shortened to TBO/3.
  - In addition to changing the oil and filters on time, the engine oil and filters must be analyzed regularly in order to ensure that the oil quality is correct. Interval: Every 100 operating hours or every three months, depending on which comes first. A decision must be made to either further reduce or extend the change intervals on the basis of the results.
  - The oil and oil filter must be replaced before biodiesel is used.
  - High-quality engine oil must be used. Operating the engine without high-quality category 2 oil leads to a deterioration in oil quality. These Fluids and Lubricants Specifications contain a list of approved oil types.
- Use a suitable tank and line system:
  - Do not use any components which contain zinc, copper or NBR seals.
  - Ensure that the system can be filled up to the fill line.
  - Minimize the entry of atmospheric oxygen through the tank vent in the event of temperature fluctuations, etc. (e.g. by installing a pressure relief valve and filter; contact your tank supplier to do this).
  - It is recommended to use a tank vent with humidity separator.
- For systems without a water separator: Retrofit a water separator to reduce the risk of microbe growth and corrosion in the fuel system.
- Regular maintenance of the water separator is mandatory. Separated water must be drained off daily, depending on the water quantity.
- Avoid longer engine downtimes and temporary shutdowns (>1 week for B20 or >3 days for B30). If downtimes can not be avoided, a suitable additive must be used to improve oxidation stability. Rolls-Royce Solutions can recommend a suitable additive on request.
- For B30:
  - The engine must be started once within 24 hours and run at idle for 5 minutes.
- For engines used seasonally, we strongly recommend flushing the fuel system, including the fuel tank, with pure, biodiesel-free, high-quality distilled diesel fuel in accordance with these Fluids and Lubricants Specifications before the engine is shut down for a relatively long period (>1 week for B20 or >3 days for B30). The reason for this is the lack of empirical data for the country-specific fuel specification.
- Prevent biodiesel from coming into contact with painted surfaces to avoid damaging and stripping the paint.
- Furthermore, always ensure that the most recent version of the Fluids and Lubricants Specifications is available and its contents are observed.

More extensive preventative measures are additionally required for some applications. Our product support department is available to answer any questions you may have on this topic.

## 6. Affected engines

This customer information applies to the following engine series:

Series	Comments
S1600Gx0	All years of manufacture
S2000Gx2	All years of manufacture
S2000Gx3	With metal low-pressure fuel lines
S2000Gx4	All years of manufacture
S2000Gx5	All years of manufacture
S2000Gx6	All years of manufacture
S4000Cx0	All years of manufacture
S4000Cx1	All years of manufacture
S4000Gx1	With metal low-pressure fuel lines
S4000Gx2	All years of manufacture
S4000Gx3	All years of manufacture
S4000Gx4	All years of manufacture
S4000Mx0	All years of manufacture
S4000Mx1	All years of manufacture
S4000Mx3	All years of manufacture
S4000Px1	All years of manufacture
S4000Px3	All years of manufacture
S4000Rx3	From year of manufacture 2020 onward / only with rest-of-world fuel filter configuration
S1163Mx4	All years of manufacture
S8000Mx1	All years of manufacture

Table 67: For the use of fuels containing up to 20% biodiesel (B20)

Series	Comments
S4000Gx3	All years of manufacture
S4000Gx4	All years of manufacture
S4000Mx0	All years of manufacture
S4000Mx1	All years of manufacture
S4000Mx3	All years of manufacture
S1163Mx4	All years of manufacture
S8000Mx1	All years of manufacture

Table 68: For the use of fuels containing more than 20% biodiesel (B20) up to a maximum biodiesel content of 30% (B30)

Should you have any questions about this customer information, please contact your local Rolls-Royce Solutions representative.

# Engine operation on pure biodiesel (B100) and vegetable oil

The standardized generic term “FAME”, (Fatty Acid Methyl Ester) is used here to designate biodiesel fuels.

## General notes

- We can make no comment with regard to the level of FAME resistance of the fuel system, which is not part of our scope of supply.
- FAME is an extremely effective solvent. Any contact with paint, for example, must therefore be avoided.
- The characteristic smell of FAME exhaust, especially during long periods of idling, may be perceived as unpleasant. The nuisance caused by smell can be reduced by an oxidation catalyst which may be installed by the vehicle / equipment manufacturers at their own risk.

### Important

Our company accepts no responsibility for and provides no warranty in respect of any fault or damage connected in any way with the use of FAME of a lower quality or resulting from noncompliance with our specifications on operation using FAME. All resultant irregularities and consequential damage lie outside our responsibility.

The following engines are approved/not approved for operation with 100% FAME in compliance with DIN EN 14214:2019-05.

## Approved/non-approved engines for operation with 100% FAME

Series	Release	Conversion necessary
SUN		Not approved
700		Not approved
750		Not approved
OM 457 LA	From series introduction	No
460	From series introduction	No
900	From series introduction	No
500	From series introduction	No
S40		Not approved
S50		Not approved
S60		Not approved
183		Not approved
2000		Not approved
396		Not approved
4000		Not approved
538		Not approved
595		Not approved
956		Not approved
1163		Not approved
8000		Not approved

Table 69:

### Important

The use of diesel fuel with a FAME content of max. 7% in compliance with EN 590:2022-05 is unproblematic. Such fuel may also be used in engines which have not been approved for operation with FAME, without affecting oil drain intervals.

## Fuel

- The FAME must comply with DIN EN 14214:2019-05. Operation with fuels of lower quality can lead to damage and malfunctions.
- Either FAME or diesel fuel may be used. The various mixtures of FAME and normal diesel fuel, which may occur in the fuel tank as a result, present no problems.

## Engine oil and servicing

- For operation using 100% FAME, engine oils are to be preferred which comply with MB Fluids and Lubricants Specifications, Sheet 228.5 or Oil Category 3 in accordance with these Fluids and Lubricants Specifications. Engine oils in accordance with Sheet 228.3 or Oil Category 2 as per these Fluids and Lubricants Specifications may also be used provided that oil drain intervals are reduced.
- A certain amount of fuel always finds its way into the engine oil via the pistons and cylinders. Its high boiling point means that FAME does not evaporate but remains in the engine oil in its entirety. Under certain conditions chemical reactions may take place between FAME and the engine oil. This can lead to engine damage.
- In case of straight FAME operation, therefore, the change intervals for engine oil and oil filters must be reduced.
- For Series 457, 460, 900 and 500 engines, special equipment is available which facilitates an increase in the engine oil change intervals for operation with 100% FAME (→ Table 70). This involves fitting the engines with special equipment Code MK21 (special unit pump) and Code MK04 (fuel prefilter with heated water separator).

## Effects on the engine oil change interval with operation with 100% FAME

Engine version	Engine oil change interval
Engines not fitted with special equipment for operation with FAME	Reduction of engine oil change interval to 30% of the standard interval required for operation with fossil diesel fuels
Engines fitted with special equipment Code MK21 and Code MK04	Reduction of engine oil change interval to 50% of the standard interval required for operation with fossil diesel fuels

Table 70:

Important
The relevant engine oil change intervals must be complied with without fail! Exceeding the engine oil change intervals can cause engine damage!

- Operation with 100% FAME requires shortened fuel filter change intervals. A new fuel filter must be fitted each time the engine oil is changed.
- FAME has a high cleaning effect, which results in a risk of clogging by loosened deposits. If a switch has been made to FAME, a fuel filter and engine oil change should therefore be carried out after approx. 25 operating hours.
- Over longer periods, fuel filter service life may be reduced as a result of old residues being carried into the filter from the fuel system. A special, approved fuel prefilter can be installed as an improvement. This fuel prefilter with heated water separator is already installed on engines fitted with special equipment Code MK04.

## Engine power and engine standstill

- Due to its calorific value, operation with 100% FAME involves a reduction of approx. 8% to 10% in engine power. This leads to a corresponding increase in fuel consumption as compared to operation with diesel fuel. Engine power corrections are not permissible.
- Prior to any extended period out of operation, the fuel system must be flushed out in order to prevent congestion. To do this, the engine must be flushed for at least 30 minutes with pure, biodiesel-free, high-grade distilled diesel fuel in accordance with these Fluids and Lubricants Specifications.

## Vegetable oils as an alternative to diesel fuel

### Important

The use of pure vegetable oils as an alternative to diesel fuel or FAME is strictly prohibited due to negative experience (engine damage caused by coking, deposits in the combustion chambers and oil sludge)!