Fluids and Lubricants Specifications

All commercial MTU series
(except Series 1000 - 1600, 1800), DDC S60 Off-Highway
and two-cycle engines

A001061/36E

Power. Passion. Partnership.

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1 Preface

1.1 General information

Used symbols and means of representation

The following instructions are highlighted in the text and must be observed:

This symbol indicates instructions, tasks and operations that must be followed to avoid hazards to persons as well as damage to or destruction of material.

Note:

A note provides special instructions that must be observed when performing a task.

Fluids and lubricants

The service life, operational reliability and function of the drive systems are largely dependent on the fluids and lubricants employed. The correct selection and treatment of these fluids and lubricants are therefore extremely important. This publication specifies which fluids and lubricants are to be used.

Test standard	Designation
DIN	Federal German Standards Institute
EN	European Standards
ISO	International Standards Organization
ASTM	American Society for Testing and Materials
IP	Institute of Petroleum
DVGW	German Gas and Water Industry Association

Table 1: Test standards for fluids and lubricants

Applicability of this publication

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Before using them, make sure you have the latest version. The latest version is also available at:

http://www.mtu-online.com/mtu/technische-info/betriebsstoffvorschriften/index.de.html

This link also takes you to the Fluids and Lubricants Specifications for the below-listed MTU series:

- MTU Series 1600
- MTU Series 1600 PowerPack®
- MTU Series 1800 PowerPack®

For Series 1000 - 1500, the Fluids and Lubricants Specifications can be found under the following link:

https://bevo.mercedes-benz.com/

If you have further queries, please contact your MTU representative.

Warranty

Use of the approved fluids and lubricants, either under the brand name or in accordance with the specifications given in this publication, constitutes part of the warranty conditions.

The supplier of the fluids and lubricants is responsible for the worldwide standard quality of the named products.

Fluids and lubricants for drive plants may be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.

These regulations are contained in the manufacturers' instructions, legal requirements and technical guidelines valid in the individual countries. Great differences can apply from country to country and a generally valid guide to applicable regulations for fluids and lubricants is therefore not possible within this publication.

Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants which it has approved.

Preservation

All information on preservation, re-preservation and de-preservation including the approved preservatives is available in the MTU Preservation and Re-preservation Specifications (publication number A001070/...). The latest version is also available at:

http://www.mtu-online.com/mtu/technische-info/konservierungs-und-nachkonservierungsvorschrift/index.de.html

2 Lubricants for Four-Cycle Engines

2.1 Engine oils

Dispose of used fluids and lubricants in accordance with local regulations.
Used oil must never be disposed of via the combustion engine!

Requirements of the engine oils for MTU approval

The MTU requirements for approval of engine oils for diesel engines are contained in the MTU Factory Standards MTL 5044 and MTL 5051 for first-use oils and corrosion-inhibiting oils. For gas engines, oil approval requirements are contained in MTU Factory Standard MTL 5074 and for two-cycle engines in MTL 5111. These standards can be ordered under these reference numbers.

Manufacturers of engine oils are notified in writing if their product is approved.

Approved diesel engine oils are divided into the following MTU Quality Categories:
- Oil category 1: Standard quality / Single and multigrade oils
- Oil category 2: Higher quality / Single and multigrade oils
- Oil category 2.1: Multigrade oils with a low ash-forming additive content (low SAPS oils)
- Oil category 3: Highest quality / Multigrade oils
- Oil category 3.1: Multigrade oils with a low ash-forming additive content (low SAPS oils)

Low SAPS oils are oils with a low sulfur and phosphor content and an ash-forming additive content of ≤1%.

They are only approved if the sulfur content in the fuel does not exceed 50 mg/kg. When using diesel particle filters, it is advisable to use these oils to avoid fast coating of the filter with ash particles.

Selection of a suitable engine oil is based on fuel quality, projected oil drain interval and on-site climatic conditions. At present there is no international industrial standard which alone takes into account all these criteria.

The use of engine oils not approved by MTU can mean that statutory emission limits can no longer be observed. This can be a punishable offense.

Mixing different engine oils is strictly prohibited!
Changing to another oil grade can be done together with an oil change. The remaining oil quantity in the engine oil system is not critical in this regard.
This procedure also applies to MTU's own engine oils in the regions Europe, Middle East, Africa, America and Asia.

When changing to an engine oil in Category 3, note that the improved cleaning effect of these engine oils can result in the loosening of engine contaminants (e.g. carbon deposits).
It may be necessary therefore to reduce the oil change interval and oil filter service life (one time during change).

Special features

MTU/MTU Detroit Diesel engine oils

The following single-grade and multigrade oils are available from MTU/MTU Detroit Diesel in the individual regions.

Manufacturer & sales region	Product name	SAE grade	Oil category	Part No.
MTU Friedrichshafen Europe Middle East Africa	Power Guard® DEO SAE 15W-40	15W-40	2	20l canister: X00062818 210l barrel: X00062819 IBC: X00064836
	Power Guard® DEO SAE 40	40	2	20l canister: X00062816 210l barrel: X00062817 IBC: X00064829
MTU America Americas	Power Guard® SAE 15W-40 Off Highway Heavy Duty	15W-40	2.1	5 gallons: 800133 55 gallons: 800134 IBC: 800135
	Power Guard® SAE 40 Off Highway Heavy Duty	40	2	5 gallons: 23532941 55 gallons: 23532942
MTU Asia Asia	Fascination of Power DEO SAE 40 Diesel Engine Oil - Cat. 1	40	1	18l canister: 80808/P 200l barrel: 81717/D
	Fascination of Power DEO SAE 15W-40 Diesel Engine Oil - Cat. 2	15W-40	2	18l canister: 91818/P 200l barrel: 92727/D
	Fascination of Power DEO SAE 40 Diesel Engine Oil - Cat. 2	40	2	18l canister: 93636/P 200l barrel: 94545/D
	Fascination of Power DEO SAE 10W-40 Diesel Engine Oil - Cat. 2	10W-40	2	18l canister: 82626/P 200l barrel: 83535/D
MTU Asia China	Diesel Engine Oil - DEO 15W-40	15W-40	2	
	Diesel Engine Oil - DEO 10W-40	10W-40	2	
	Diesel Engine Oil - DEO 5W-30	5W-30	3	
MTU Asia Indonesia	Diesel Engine Oil - DEO 15W-40	15W-40	2	20l canister: 64242/P 205l barrel:
MTU Detroit Diesel Australia	MTU Premium Plus 15-W40	15W-40	2	
	MTU Premium SAE 40 - Off-Highway	40	2	
	MTU Premium SAE 30	30	2	
MTU India Pvt. Ltd. India	Diesel Engine Oil - DEO 15W-40	15W-40	2	20l canister: 63333/P 205l barrel:
	Diesel Engine Oil - DEO 40	40	2	20l canister: 73333/P 205l barrel: 75151/D

Table 2:

Restrictions for applications in Series 2000 and 4000

BR 2000: Cx6, Gx6, Gx7, Mx6, M84, M94, Sx6

Series 4000: M73-M93L, N43 and N83 and 4000-03 Genset (application group 3F, 3G, 3H)

Oils in oil category 1 must not be used!

Restrictions for applications in Series 2000 M72

Mobil Delvac 1630/1640 and Power Guard® SAE 40 Off-Highway Heavy Duty must not be used!

Restrictions on Series 4000 C, R, T application

In engines in Series 4000 C64, T94 and T94L, only engine oils of oil category 3 or 3.1 of SAE grades 5W-40 or 10W-40 must be used!
Exceptions:

- For Series 4000 T, Chevron Delo 400 LE SAE 15W-40 (oil category 2.1) can also be used.
- For Series 4000 T, Fleet Supreme EC SAE 15W-40 (oil category 2.1) can also be used.

In engines in Series 4000 R64, R74 and R84, only engine oils of oil category 3.1 of SAE grades 5W-40 or 10W-40 must be used!

The maximum oil service life is 1000 operating hours with observance of the analytical limit values for used oils!

Restrictions on Series 8000 applications

Only the following engine oils may be used:

- Castrol HLX SAE 30 / SAE 40
- Chevron Delo 400 SAE 30 / SAE 40
- Exxon Mobil Delvac 1630 SAE 30
- Exxon Mobil Delvac 1640 SAE 40
- PowerGuard® SAE 40 Off-Highway Heavy Duty (material number: 5 gallons 23532941; 55 gallons 23532942)
- Shell Sirius X SAE 30 / SAE 40

SAE grade 40 engine oils may only be used in combination with preheating and oil priming ($T_{oil\ >30\ °C}$).

Restrictions for Series S60 applications

Only multigrade oils of SAE grade 15W-40 marked with index [2)] must be used.
The maximum oil service life is 250 operating hours or 1 year.

Restrictions when using low SAPS oils

Oil Categories 2.1 and 3.1 may be used if the sulfur content in the fuel does not exceed 50 mg/kg.

Restrictions for applications in Series 595 and 1163

Category 2 or Category 3 oils are normally stipulated for fast commercial ferries using Series 595 and Series 1163 engines.

Restrictions for applications in Series 956 TB31 / TB32 / TB33 / TB34 and 1163 TB32

Engine oils of oil categories 1, 2.1 and 3.1 are generally not approved!

Only the following engine oils are currently approved for Series 956 TB 31, TB 32, TB 33, TB 34 engines for nuclear power station applications and for Series 1163-02 TB32 engines.

Series	Oil category 2, single-grade oil	Oil category 2, multi-grade oil	Oil category 3
956 TB 31	Power Guard® SAE 40 Off-Highway Heavy Duty Mobil Delvac 1630 Mobil Delvac 1640	Shell Rimula R3X 15W-40	No approval
956 TB 32	Power Guard® SAE 40 Off-Highway Heavy Duty Mobil Delvac 1640	Shell Rimula R3X 15W-40	No approval
956 TB 33 Ɛ = 9	Power Guard® SAE 40 Off-Highway Heavy Duty Mobil Delvac 1640 Q8 T750 SAE 30	No approval	No approval
956 TB 33 Ɛ = 12	Shell Sirius X 30	Fascination of Power DEO SAE 15W40 Diesel Engine Oil - Cat. 2 Shell Rimula R3X 15W-40 Lukoil Avantgarde Ultra 15W40	Shell Rimula R6 M SAE 10W-40
956 TB 34	Shell Sirius X 30	Fascination of Power DEO SAE 15W40 Diesel Engine Oil - Cat. 2 Shell Rimula R3X 15W-40	Shell Rimula R6 M SAE 10W-40
1163-02 TB 32 Emergency power, gen-set	Shell Sirius X 30	Fascination of Power DEO SAE 15W40 Diesel Engine Oil - Cat. 2	

Table 3:

Engine oil approvals upon customer request for applications in Series 956 TB 31, TB32, TB33, TB34

The engine oil must have valid MTU approval as per MTL 5044 and a quality level of oil category 2 or 3.

For customer certification, an engine test run under the following conditions is required:
- Engine runtime with specific oil: min. 50 hours (30 hours of which at min. 100% power)
- Then endopscopic examination of combustion chambers.
- Disassembly of 4 pistons (2 on engine A-side and 2 on engine B-side) for detailed results.

Engine oils for engines with exhaust aftertreatment

Engines with exhaust aftertreatment place special demands on the oils used to guarantee the operational reliability and service life of the exhaust system and the engine.

Depending on the technology used for exhaust aftertreatment, the following oils can be used.

Exhaust gas technology	Approval for oil category				
	1	2	2.1	3	3.1
Oxidation catalyst without particulate filter	no[1)]	no[1)]	yes	no[1)]	yes
SCR system with vanadium catalysts (no particulate filter)	no[1)]	no[1)]	yes	no[1)]	yes
SCR system with zeolith catalysts (no particulate filter)	no[1)]	no[1)]	yes	no[1)]	yes
Diesel particulate filter	no[1)]	no[1)]	yes	no[1)]	yes
Combination system SCR+ particulate filter	no[1)]	no[1)]	yes	no[1)]	yes

Table 4:

[1)] = individual test possible for optional and retrofitted exhaust aftertreatment systems

The use of engine oils of categories 1, 2 and 3 (with ash content >1%) on plants with exhaust aftertreatment results in a significantly reduced service life of the exhaust aftertreatment system and, with particulate filters, increased back pressure.

For EPA Tier 4i or Tier 4 and EU IIIb-certified engines with exhaust aftertreatment, only low-ash engine oils of category 2.1 or 3.1 are permitted.

Any possible restrictions related to engine requirements must also be observed.

Selection of viscosity grades

Selection of the viscosity grade is based primarily on the ambient temperature at which the engine is to be started and operated. If the relevant performance criteria are observed the engines can be operated both with single grade and multigrade oils, depending on the application. Standard values for the temperature limits in each viscosity grade are shown in (→ Figure 1).

If the prevailing temperature is too low, the engine oil must be preheated.

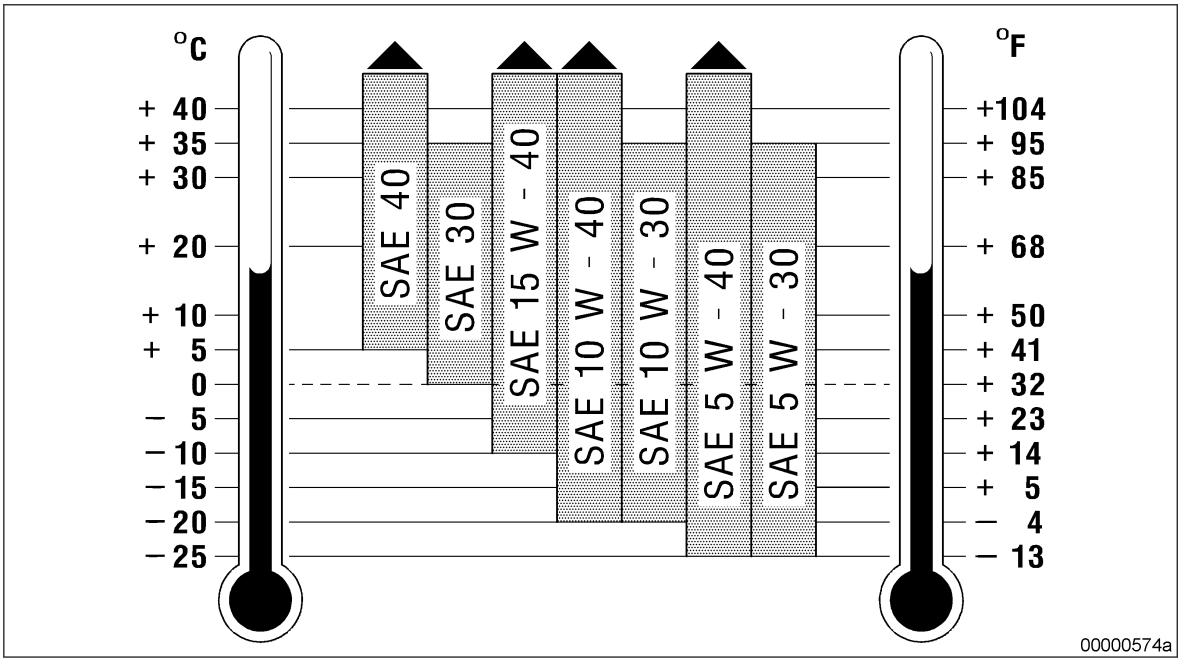

Figure 1: Viscosity grade chart

Oil drain intervals for diesel engines

Engine oil drain intervals depend on the engine-oil quality, its conditioning, the operating conditions and the fuel used.

The intervals quoted (Table) are guidelines based on operational experience and are valid for applications with a standard load profile.

Oil change intervals

Oil category	Without centrifugal oil filter	With centrifugal oil filter or by-pass filter
1	250 operating hours	500 operating hours
2	500 operating hours	1000 operating hours
2.1[1)]	500 operating hours	1000 operating hours
3	750 operating hours	1500 operating hours
3.1[1)]	750 operating hours	1500 operating hours

Table 5:

[1)] = To be used in conjunction with fuels with max. 50 mg/kg sulfur content.

The oil drain intervals in the table are recommended guidelines when using diesel fuels with < 0.5% sulfur content. The defined limit values for the used oil (→ Table 6) must be observed. The numbers of operating hours quoted for oils must be confirmed by means of oil analysis.

The oil drain intervals must be determined by oil analysis if one or more of the following difficult operating conditions are encountered:
- Extreme climatic conditions
- High engine start-up frequency
- Frequent and prolonged idling or low-load operation
- High fuel sulfur content of 0.5 to 1.5% by weight (see "Use of High-Sulfur Fuel")

For applications involving low runtimes, the engine oil must be changed every two years at the latest irrespective of its category.

Where engine oils with higher-grade corrosion-inhibiting characteristics are in use (→ Page 84), a change must be carried out every 3 years at the latest.

In individual cases the service life of the engine oil can be optimized by regular laboratory analysis and appropriate engine inspections in consultation with the MTU service point responsible:

The first oil sample should be taken from the engine as a "basic sample" after the engine has run for approximately 1 hour after being filled with fresh oil.

Further samples are to be analyzed at specific intervals (see "Laboratory Analysis").

The appropriate engine inspections are to be carried out before and after the oil analyses. After completion of all analyses, and depending on the findings, special agreements can be reached for individual cases.
Oil samples must always be taken under the same conditions and at the point provided for that purpose (see Operating Instructions).

Special additives

Engine oils approved have been specially developed for diesel engines and have all necessary properties. Further additives are therefore superfluous and may even be harmful.

Laboratory analysis

Spectrometric oil analysis

Analysis of the engine oil's additive-metal content is carried out by the MTU laboratory to determine the brand of oil.

MTU does not generally analyze the oil's wear-metal contents in order to determine the degree of engine wear. These content levels are very much dependent on the following factors, among others:
- Individual engine equipment status
- Tolerance scatter
- Operating conditions
- Duty profile
- Fluids and lubricants
- Miscellaneous assembly materials

Unambiguous conclusions as to the wear status of the engine components involved are therefore not possible. This means that no limit values can be given for wear-metal contents.

Used-oil analysis

In order to check the used oil, it is recommended that regular oil analyses be carried out. Oil samples should be taken and analyzed at least once per year and during each oil change and under certain conditions, depending on application and the engine's operating conditions, sampling / analysis should take place more frequently.

The specified test methods and limit values (Analytical Limit Values for Used Diesel Engine Oils) (→ Table 6) indicate when the results of an individual oil sample analysis are to be regarded as abnormal.

An abnormal result requires immediate investigation and remedy of the abnormality.

The limit values relate to individual oil samples. When these limit values are reached or exceeded, an immediate oil change is necessary. The results of the oil analysis do not necessarily give an indication of the wear status of particular components.

In addition to the analytical limit values, the engine condition, its operating condition and any operational faults are decisive factors with regard to oil changes.

Some of the signs of oil deterioration are:
- Abnormally heavy deposits or precipitates in the engine or engine-mounted parts such as oil filters, centrifugal oil filters or separators, especially in comparison with the previous analysis.
- Abnormal discoloration of components.

Analytical limit values for used diesel engine oils

	Test method	Limit values	
Viscosity at 100 °C max. mm²/s	ASTM D445 DIN 51562	SAE 30 SAE 5W-30 SAE 10W-30	15.0
		SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40	19.0
min. mm²/s		SAE 30 SAE 5W-30 SAE 10W-30	9.0
		SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40	10.5
Flashpoint °C (COC)	ASTM D92 ISO 2592	Min. 190	
Flashpoint °C (PM)	ASTM D93 DIN EN ISO 2219	Min. 140	

	Test method	Limit values
Soot content (by weight %)	DIN 51452 CEC-L-82-A-97	Max. 3.0 (Oil category 1) Max. 3.5 (Oil category 2, 2.1, 3 and 3.1)
Total base number (mg KOH/g)	ASTM D2896 ISO 3771 DIN 51639	Min. 50% of new-oil value
Proportion of water (vol. %)	ASTM D6304 EN 12937 ISO 6296	Max. 0.2
Oxidation (A/cm)[1)]	DIN 51453[1)]	Max. 25
Ethylene glycol (mg/kg)	ASTM D2982	Max. 100

Table 6:

[1)] = only possible if there are no ester compounds

Use of high-sulfur diesel fuel

The following measures must be taken in the case of diesel fuels with a sulfur content above 0.5%:
- Use of an engine oil with a total base number (TBN) of more than 8 mgKOH/g
- Shorten the oil-change intervals (see Oil change intervals).

Chart (→ Figure 2) (Total Base Numbers) lists the recommended minimum total base numbers for new and used oils depending on the sulfur content of the diesel fuel.

The total base numbers for the approved engine oils are listed in chapter Approved engine oils (→ Page 84).

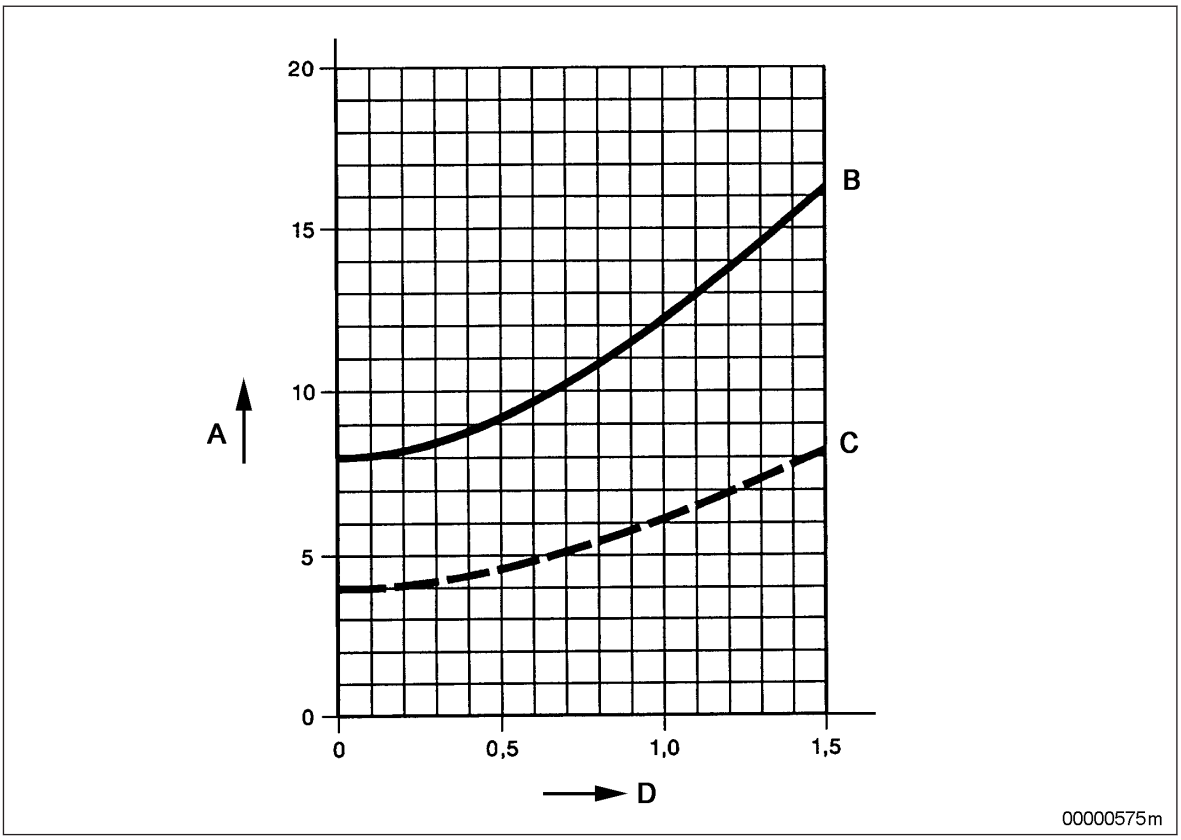

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Figure 2: Total base number for engine oil depending on sulfur content of the diesel fuel

A Total base number in mgKOH/g, ISO 3771
B Recommended min. total base number for fresh oil
C Min. total base number for used oil
D Sulfur content of fuel in % weight

Use of low-sulfur diesel fuel

The use of diesel fuels with low sulfur content (< 0.5%) does not influence the oil drain intervals.

Minimum requirements for operational checks

Oil analyses can be carried out using the MTU Test Kit. The Test Kit contains all the equipment required as well as instructions for use.

The following checks can be performed:
- Determination of oil dispersing capacity (spot test)
- Determination of diesel fuel content in the oil.
- Determination of water content in oil

2.2 Fluorescent dyestuffs for detecting leaks in the lube oil circuit

The fluorescent dyestuffs listed below are approved for detection of leaks in the lube oil circuit.

Manufacturer	Product name	Concentration for use	Part No.	Container size	Storage stability[1)]
Chromatech Europe B.V.	D51000A Chromatint Fluorescent Yellow 175	0.04 % - 0.07 %	X00067084	16 kg	2 years
Cimcool, Cincinnati	Producto YFD-100	0.5% - 1.0 %		5 gallons (canister) 55 gallons (barrel)	6 months

Table 7:

[1)] = ex works delivery, based on original and hermetically sealed containers in frost-free storage (> 5 °C).

The fluorescence (light-yellow color tone) of both dyestuffs is made visible with a UV lamp (365 nm).

2.3 Lubricating greases

Requirements

The MTU conditions for lubricating-grease approval are specified in the MTU Factory Standard MTL 5050, which can be ordered under this reference number.

Grease manufacturers are notified in writing if their product is approved by MTU.

Lubricating greases for general applications

Lithium-saponified greases are to be used for all lubrication points with the exception of:
- Emergency-air shutoff flaps fitted between turbocharger and intercooler (see Special-purpose lubricants)
- Coupling internal centering

Lubricating greases for applications at high temperatures

High-temperature grease (up to 250 °C) must be used for emergency-air shutoff flaps located between turbocharger and intercooler:
- Aero Shell Grease 15
- Optimol Inertox Medium

General purpose greases suffice for emergency-air shutoff flaps located before the turbocharger or after the intercooler.

Greases for internal centerings of couplings

Greases for internal centerings:
- Esso Unirex N3 (stable up to approx. 160 °C)

Special-purpose lubricants

Oil for turbochargers

Exhaust turbochargers with integrated oil supply are generally connected to the engine oil system.

For ABB turbochargers which are not connected to the engine lube oil system, mineral-based turbine oils with viscosity grade ISO-VG 68 must be used.

Lubricating greases for curved tooth couplings

Depending on the application, the following lubricants have been approved for curved tooth couplings:
- - Klüber: Structovis BHD MF (highly viscous lubricating oil)
- - Klüber: Klüberplex GE11–680 (adhesive transmission lubricant)

Guidelines on use and service life are contained in the relevant Operating Instructions and Maintenance Schedules.

3 Lubricants for Gas Engines

3.1 Engine oils

Dispose of used fluids and lubricants in accordance with local regulations.

Mixing different engine oils is strictly prohibited!
Changing to another oil grade can be done together with an oil change. The remaining oil quantity in the engine oil system is not critical in this regard.

Engine oil requirements for gas engines

Viscosity grade SAE 40 is stipulated for gas engines!
Multigrade oils are not permitted!

The selection of a suitable engine oil for gas engines depends primarily on the composition of the fuel used to power the engine. The gas engine must only be operated with approved lube oil. The engine oils to be used must be taken from the table (→ Page 113). Another significant factor is the quality of the gas regarding its purity. This requires that the operator regularly carries out gas checks. The gas engine oils to be used are characterized by the lowest possible ash content. This prevents increased ash deposits which can lead to reduced catalytic converter performance or combustion knocking.

Oil drain intervals for gas engines Series 4000

Engine oil drain intervals depend on the engine-oil quality, its conditioning, the operating conditions and the fuel used.

For this reason, an oil sample must be taken every 250 operating hours and the oil analysis must be compared to the limit values (→ Table 8). The oil samples must always be taken under the same site conditions (engine at operation temperature) and at the designated point (extraction nozzle on oil filter housing). When the limit values (→ Table 8) are reached or exceeded, an immediate oil change is necessary. When using increased oil volumes, the limit values for wear elements must be reduced inversely proportionally to the volume increase (see following example).

Double oil volume = halved limit value of the wear element (e.g. iron (Fe) –> 15 mg/kg)

The maximum permissible reduction of limit value for the wear elements is 50% of the limit value (→ Table 8)

The results of the oil analyses must be archived and the last respective oil sample must be stored for any necessary follow-up examinations.

If the limit values are not achieved, an oil change must be carried out after one year at the latest.

Special gas

During operation with gases containing silicium, take particular note of the increased silicium content in the oil. For this purpose, the silicium operational value Si_B must be calculated with the help of the formula below (→ Figure 3). The limit value for the silicium operational value is 0.01. If this value is exceeded, the engine is being operated outside the fuel specifications and the warranty becomes void. More details can be obtained in the chapter "Fluids and lubricants for gas engines" (→ Page 73). The comprehensive observance of Si_B must be verified by the operating company with the help of oil analyses $Si_{(n)}$.

$$Si_B = \text{Delta Si (ppm) Ölanalyse } (Si_{(n)} - Si_{(n-1)}) \times \frac{\text{[Ölfüllmenge + Nachfüllmenge (Liter)]}}{\text{erzeugte elektrische Arbeit [kWh]}}$$

Figure 3:

If the permissible limit values for chlorine, fluorine, sulfur and silicium compounds in the fuel are exceeded, this can result in corrosive wear, combustion chamber deposits and accelerated reduction of the alkaline lube oil reserve.

In this case, gas conditioning is absolutely necessary.

Oil drain intervals for gas engines Series 4000

See Maintenance Schedule

Analytical limit value for used gas engine oils SAE 40

	Test method	Limit values
Viscosity at 100 °C (mm²/s)	ASTM D445 DIN 51562	Max. 17.5 Min. 11.5
Total base number (mg KOH/g)	ASTM D2896 ISO 3771	Min. 3 and TBN > TAN
Acid number, TAN (mgKOH/g)	ASTM D664	New oil value + 2.5
iph value		Min. 4.5
Water (% by vol.)	ASTM D6304 EN 12937 ISO 6296	Max. 0.2
Glycol (mg/kg)	ASTM D2982	Max. 100
Oxidation (A/cm)	DIN 51453	Max. 20
Nitration (A/cm)	IR method	Max. 20
Wear elements (mg/kg) Iron (Fe) Lead (Pb) Aluminum (Al) Copper (Cu) Tin (Sn) Silicium (Si)	RFA, ICP	 Max. 30 Max. 20 Max. 10 Max. 20 Max. 5 Max. 15 *

Table 8:

- * The limit value for the wear element Si only refers to natural gas operation

4 Lubricants for Two-Cycle Engines

4.1 Engine oils

Dispose of used fluids and lubricants in accordance with local regulations.
Used oil must never be disposed of via the fuel tank!

Engine oil requirements for two-cycle engines of Series 53/71/92 and 149

Specification	Test method		SAE grade	
			40	50
API CF-2	ASTM	ISO	Limit values	Limit values
Viscosity at 100 °C (mm^2/s)	D445	EN 3104	12.5 - 16.3	16.3 - 21.9
Viscosity at 40 °C (mm^2/s)	D445	EN 3104	130 - 150	200 - 300
Pour point (°C)	D97	3016	Max. -15	Max. -10
Flashpoint (°C)	D92	2592	Min. 225	Min. 230
Sulfated ash (by weight %)	D874	DIN 51575	Max. 1.0	Max. 0.8
Total base number (mgKOH/g)	D2896	3771	7.0 - 10.0	Min. 7.0
Calcium (mg/kg)		14596	No limit value	Max. 500
Phosphor mg/kg		DIN 51363-2/3	Min. 700	Max. 100
Zinc (mg/kg)		DIN 51391-3	Min. 700	Max. 100

Table 9:

Special features

The following listed two-cycle engine oils are available at MTU America:

MTU engine oils for two-cycle engines

Manufacturer & sales region	Product name	SAE grade	Specification	Comments / material number
MTU America Americas	PowerGuard® Heavy Duty Engine Oil for Detroit Diesel 2-Cycle (4x1G) SAE 40	40	API CF-2	4x1 gallons: 23512701
	PowerGuard® Heavy Duty Engine Oil for Detroit Diesel 2-Cycle SAE 40	40	API CF-2	5 gallons: 23512734 55 gallons: 23512702 IBC: 23512739

Table 10:

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Restrictions for Series 53/71/92 applications - all applications except marine

Start failures may occur at ambient temperatures < 0 °C when the engine is operated with SAE grade 40 oils.
If no start aids are available, oils of SAE grade 30 may be used as a short-term solution.
At lower temperatures (-18 to -32 °C) oils of SAE grade 15W-40 may also be used. These oils must, however, comply with the specification API CF-2 and have a high-temperature viscosity of min. 3.7 cP at 150 °C.
The oil grade must be changed back to SAE 40 as soon as the temperatures allow to do so.

Restrictions for Series 53/71/92 marine applications

No single-grade oils of SAE grade 30 or multigrade oils must be used!

Restrictions for Series 53/71/92 applications

For applications with coolant outlet temperatures > 94 °C, oils of SAE grade 50 must be used!
If fuels with low-sulfur content of 0.5 to 1.0% are used, the oil service life is shortened.

Restrictions for Series 149 applications

For applications with ambient temperatures > 35 °C, oils of SAE grade 50 must be used!
Oil of SAE grade 50 can no longer be recommended at ambient temperatures <7 °C.
If starting speed is no longer reached with the use of SAE grade 50 oils, oil from SAE grade 40 can also be used.
No single-grade oils of SAE grade 30 or multigrade oils must be used!
If fuel with a sulfur content of between 0.5 and 1% are used, oils with a base number of at least 10 mg/KOH/g and with zinc and phosphor contents of max. 100 mg/kg must be used!

Analytical limit values for used diesel two-cycle engine oils

	ASTM	ISO	Limit value SAE 40	Limit value SAE 50
Viscosity at 100 °C (mm^2/s)	D445	EN 3104	Min. 12.5 Max. 16.3	Min. 16.0 Max. 22.0
Soot content (by weight %)		DIN 51452	Max. 0.8	Max. 0.8
Water (% by vol.)	D1744	EN 12937	Max. 0.3	Max. 0.3
Ethylene glycol	D2982	DIN 51375	Negative	Negative
Iron (mg/kg)	ASTM D5185		Max. 150	max. 35
Aluminum, silicium, copper (mg/kg)	ASTM D5185		Max. 25	Max. 25
Lead (mg/kg)	ASTM D5185		Max. 10	Max. 10

Table 11:

Oil change intervals with use of fuels with sulfur content < 0.5%

Application	Series	Oil change interval
C&I, Marine	S 53/71/92	150 h or 1 year
C&I, Marine	S 149	300 h or 1 year

Application	Series	Oil change interval
Generator - emergency power	S 53/71/92/149	150 h or 6 months
Generator - continuous operation	S 53/71/92/149	150 h or 3 months

Table 12:

5 Coolants

5.1 General information

Coolant definition

Engine coolant	= coolant additive (concentrate) + freshwater to predefined mixing ratio ready for use in engine.

The corrosion-inhibiting effect of coolant is only ensured with the coolant circuit fully filled. The only exception is Oil 9156, which maintains its corrosion-inhibiting character even when the coolant was drained due to oil-film formation in the circuit.

Apart from that, only the corrosion inhibitors approved for internal preservation of the coolant circuit provide proper corrosion protection when the medium was drained. This means that after draining the coolant the cooling circuit must be preserved if no more coolant is to be filled. The procedure is described in the MTU Preservation specifications A001070/.. of the engine.

Coolants must be prepared from suitable freshwater and an MTU-approved coolant additive. Conditioning of the coolant takes place outside the engine.

Mixing of different coolant additives and supplementary additives is prohibited!

The conditions for the approval of coolant additives are specified in the following MTU works standards (MTL):
- MTL 5047: Emulsifiable corrosion-inhibiting oils
- MTL 5048: Corrosion-inhibiting antifreeze
- MTL 5049: Water-soluble corrosion inhibitors

Coolant manufacturers are informed in writing if their product is approved by MTU.

To prevent cooling system damage:

- When topping up (following loss of coolant) it must be ensured that not only water but also concentrate is added. The specified antifreeze and/or corrosion inhibitor concentration must be maintained.
- Do not use concentrations of corrosion-inhibiting additives exceeding 55% by volume (max. antifreeze protection). Concentrations in excess of this reduce antifreeze protection and heat dissipation. Only exception: BASF G206 (special application)
- The coolant must not contain any oil or copper residue (in solid or dissolved form).
- The majority of corrosion inhibitors currently approved for internal coolant circuit preservation are water-soluble and do not provide antifreeze protection. Make sure that the engine is stored safe from frost, because a certain amount of coolant remains in the engine after draining.
- A coolant circuit can not usually be drained completely, i.e. residual quantities of used coolant or freshwater from a flushing procedure remain in the engine. These residual quantities can result in the dilution of a coolant to be filled (mixed from a concentrate or use of a ready mixture). This dilution effect is higher the more add-on components there are on the engine. Check the coolant concentration in the coolant circuit and adapt it if necessary.

All coolants approved in these Fluids and Lubricants Specifications generally relate only to the coolant circuit of MTU engines. In the case of complete propulsion plants, the operating fluids approvals of the component manufacturer must be observed!

For corrosion-related reasons, it is not permissible to operate an engine with pure water without the addition of an approve corrosion inhibitor!

Special features

MTU/MTU-Detroit Diesel coolant

The following coolant additives are available from MTU/MTU-Detroit Diesel.

Manufacturer & sales region	Product name	Type
MTU Friedrichshafen, MTU Asia Europe Middle East Africa Asia	Coolant AH 100 Antifreeze Concentrate	Corrosion-inhibiting antifreeze concentrate
	Coolant AH 35/65 Antifreeze Premix	Corrosion-inhibiting antifreeze ready mixture
	Coolant CS 100 Corrosion Inhibitor Concentrate	Water-soluble corrosion inhibitor concentrate
	Coolant CS 10/90 Corrosion Inhibitor Premix	Water-soluble corrosion inhibitor, ready mixture
MTU America Americas	Power Cool® Off-Highway Coolant Concentrate	Corrosion-inhibiting antifreeze concentrate
	Power Cool® Off-Highway Coolant 50/50 Premix	Corrosion-inhibiting antifreeze ready mixture
	Power Cool®Universal 50/50 mix	Corrosion-inhibiting antifreeze ready mixture
	Power Cool®Universal 35/65 mix	Corrosion-inhibiting antifreeze ready mixture
	Power Cool®3149	Corrosion-inhibiting antifreeze concentrate, two-cycle engines
	Power Cool®Plus 6000 Concentrate	Water-soluble corrosion inhibitor, concentrate
MTU Detroit Diesel Australia Australia	Power Cool HB 800	Corrosion-inhibiting antifreeze concentrate
	Power Cool HB 800 Premix 50/50	Corrosion inhibiting antifreeze ready mixture
	Power Cool HB 500	Corrosion-inhibiting antifreeze concentrate
	Power Cool HB 500 Premix 50/50	Corrosion inhibiting antifreeze ready mixture

Table 13:

Note:

For ready mixtures, the proportion of coolant additive (concentrate) is always named first.

Example:

Coolant AH 40/60 Antifreeze Premix = 40% by vol. coolant additive / 60% by vol. freshwater

5.2 Unsuitable materials in the coolant circuit

Components made of copper, zinc and brass materials

Unless various preconditions are observed, components made of copper, zinc and brass materials in the coolant circuit can cause an electrochemical reaction in conjunction with base metals (e.g. aluminum). As a result, components made of base metals are subject to corrosion or even corrosive pitting. The coolant circuit becomes leaky at these points.

Requirements

Based on current knowledge, the following materials and coatings must not be used in an engine coolant circuit because negative mutual reactions can occur even with approved coolant additives.

Metallic materials

- no galvanized surfaces
  The entire cooling system must be free of zinc components. This also applies to coolant supply and drain lines as well as to storage containers.
- No copper-based alloys a material with the use of coolant containing nitrite, with the exception of the following to alloys:
  - CuNi10Fe1Mn corresponds to CW-352-H
  - CuNi30Mn1Fe corresponds to CW-354-H
- Do not use components containing brass in the coolant circuit (e.g. coolers made of CuZn30) if exposed to ammoniacal solutions (e.g. amines, ammonium, ...) and solutions containing nitrite or sulfide. Stress-corrosion cracking is possible in the presence of tensile stress and a critical potential area. "Solutions" refer to cleaning agents, coolant and similar substances.

Non-metallic materials

- Do not use EPDM and no silicon elastomers when using emulsifiable corrosion inhibitor oils or other types of oil introduced to the coolant circuit.

Information:

In case of doubt about the use of materials on the engine and add-on components / components in coolant circuits, consultation with the respective MTU specialist department must be held.

5.3 Freshwater requirements

Only clean, clear water with values in accordance with those in the following table must be used for preparing the coolant. If the limit values for the water are exceeded, hardness or mineral content can be decreased by adding de-mineralized water.

For preparation of aqueous corrosion inhibitors and corrosion-inhibiting antifreeze:

Item	Minimum	Maximum
Sum of alkaline earth metals *) (Water hardness)	0 mmol/l 0°d	2.7 mmol/l 15°d
pH-value at 20 °C	6.5	8.0
Chloride ions		100 mg/l
Sulfate ions		100 mg/l
Anions total		200 mg/l
Bacteria		10^3CFU (colony forming unit)
Fungi, yeasts	are not permitted!	

Table 14:

*) Common designations for water hardness in various countries:

1 mmol/l = 5.6°d = 100 mg/kg $CaCO_3$
- 1°d = 17.9 mg/kg $CaCO_3$, USA hardness
- 1°d = 1.79° French hardness
- 1°d = 1.25° English hardness

For preparation of emulsifiable corrosion inhibitors:

Item	Minimum	Maximum
Sum of alkaline earth metals *) (Water hardness)	0.36 mmol/l 2°d	1.8 mmol/l 10°d
pH-value at 20 °C	7.0	8.0
Chloride ions		100 mg/l
Sulfate ions		100 mg/l
Anions total		200 mg/l
Bacteria		10^3CFU (colony forming unit)
Fungi, yeasts	are not permitted!	

Table 15:

*) Common designations for water hardness in various countries:

1 mmol/l = 5.6°d = 100 mg/kg $CaCO_3$
- 1°d = 17.9 mg/kg $CaCO_3$, USA hardness
- 1°d = 1.79° French hardness
- 1°d = 1.25° English hardness

If the water is too soft, this can result on foam formation and the water has to be hardened before application by adding hard water. If the water is too hard, this impairs the emulsion stability. This causes increased oil separation and the formation of deposits in the system. Excessively hard water must therefore be softened by blending with soft water.

5.4 Emulsifiable corrosion-inhibiting oils

Emulsifiable corrosion-inhibiting oils

Emulsions of MTU-approved corrosion-inhibiting oils (1.0 – 2.0% by volume) and suitable freshwater (→ Page 26) provide adequate corrosion protection.

A 2% by volume concentration must be used for initial filling.

The required quantity of corrosion-inhibiting oil is best mixed in advance in a container with 4 to 5 times the amount of freshwater and then added to the coolant when the engine is running at operating temperature.

In maintenance stations or multi-engine installations the complete amount of coolant required should be prepared in a separate container. It can then be used for initial filling or replenishment as required.

Under unfavorable conditions, individual cases of bacterial attack may occur in the emulsifiable corrosion-inhibiting oils. Treat the coolant emulsion with biocide in this case! Refer to chapter "Flushing and cleaning specifications for engine cooling circuits" (→ Page 155).

Note:

Slight precipitation may occur where coolant emulsions are used. This is shown by a layer on the surface of the coolant in the expansion tank. This is of no significance provided that the emulsion concentration remains within the specified limit values. Change the coolant in the event of a sudden drop in coolant additive concentration or if the additive is no longer absorbed. If necessary, the engine coolant chambers are to be cleaned, see the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 155).

Emulsifiable corrosion-inhibiting oils must not be used in engines of the following series:

- Series 099
- Series 183
- Series 2000
- Series 396
- Series 4000
- Series S60
- Two-cycle engines

The series with application approval for emulsifiable corrosion inhibitor oils are listed in the chapter "Approved coolants" (→ Page 117).

For the following listed serial numbers of the Series 20V 956 TB33 up to year of manufacture end of 2008 (as per identification plate), only emulsifiable corrosion inhibitor oil must be used:

Serial number	Serial number	Serial number	Serial number	Serial number
5870001	5870002	5870003	5870004	5870005
5870006	5870007	5870008	5870009	5870010
5870011	5870012	5870013	5870014	5870015
5870016	5870017	5870018	5870019	

Table 16:

Special approval presently in effect remain valid.

The emulsifiable corrosion-inhibiting oil must never be used for coolant temperatures >90 °C!

Flushing with water is required after every change to a different coolant product. For preserved engines (new engines, field engines, reserve stock engines, etc.), a flushing run must be carried out prior to filling with engine coolant. The necessary work is described in the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 155).

5.5 Corrosion-inhibiting antifreezes

These antifreezes are necessary for engines without heating facilities and operating in areas where below-freezing temperatures may occur.

Most of the corrosion-inhibiting antifreezes approved at MTU are based on ethylene glycol.

Exceptions:
- Ready mixture of Fleetguard PG XL based on propylene glycol (→ Page 154)
- Concentrate BASF G206 as a mixture of ethylene glycol and propylene glycol

Provided that they are used in approved concentrations, corrosion-inhibiting antifreezes approved by MTU provide effective protection, see Operational monitoring (→ Page 31).

The corrosion-inhibiting antifreeze concentration must be determined not only in accordance with the minimum anticipated temperatures but with the corrosion protection requirements also.

For approved coolant additives for the individual engine series, refer to chapter "Approved coolants" (→ Page 117).

Special approval presently in effect remain valid.

Coolant additives containing nitrite must not be used in conjunction with coolers that contain brass!

Marine engines are subject to the following limitations when using corrosion-inhibiting antifreezes:

- Series 956-01, 956-02, 1163-02, 1163-03, 1163-04:
  These engines are fitted with heating units. Because of their cooler capacity, corrosion-inhibiting antifreezes must not be used.
- Series 099, 183, 396:
  The use of corrosion-inhibiting antifreeze in these engines is permitted only at seawater temperatures of up to 20 °C maximum.
- Series 2000 and 4000:
  Corrosion-inhibiting antifreeze may be used with these engines with installed heat exchanger at seawater temperatures up to 25 °C max.The use of corrosion-inhibiting antifreezes is generally not allowed on engines with no installed heat exchanger.Ensure that the heat exchanger not installed on the engine is sufficiently dimensioned.
- Series 538, 595 and 8000:
  The use of corrosion-inhibiting antifreezes is not allowed for these engines.

The possibility of using corrosion-inhibiting antifreezes for the above-mentioned series for other applications (e.g. genset, rail) is described in the overview in the chapter "Approved coolants" (→ Page 117).

Note:

Propylene glycol-based corrosion-inhibiting antifreezes are stipulated for use in some types of applications. These products have a lower thermal conductivity than the usual ethylene glycol products. This brings about a higher temperature level in the engine.

The product BASF G206 is available for use at extremely low temperatures (< -40 °C).

Flushing with water is required at every change to a different coolant product. For preserved engines (new engines, field engines, reserve stock engines, etc.), a flushing run must be carried out prior to filling with engine coolant if the engines were preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 155).

5.6 Water-soluble corrosion inhibitors

Water-soluble corrosion inhibitors are required for higher coolant temperatures and large temperature drops in heat exchangers, e.g. in TB systems (with plate-core heat exchanger) and TE systems in Series 099, 183, 2000, 396 and 4000 engines.

The watersoluble corrosion inhibitors recommended by MTU ensure adequate protection provided the correct concentrations are used. The relevant concentration range for use is listed in the section on operational monitoring.

For approved coolant additives for the individual engine series, refer to chapter "Approved coolants" (→ Page 117).

Special arrangements presently in effect remain valid.

Coolant additives containing nitrite must not be used in conjunction with coolers that contain brass!

Flushing with water is required after every change to a different coolant product. For preserved engines (new engines, field engines, reserve stock engines, etc.), a flushing run must be carried out prior to filling with engine coolant if the engines were preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 155).

5.7 Operational monitoring

Inspection of the freshwater and continuous monitoring of the coolant are essential for trouble-free engine operation. Freshwater and coolant should be inspected at least once per year and with each fill-up. Inspections can be carried out using the MTU Test Kit which contains the necessary equipment, chemicals and instructions for use.

The following tests can be conducted with the MTU Test Kit:
- Determination of total hardness (°d)
- pH value
- Chloride content of freshwater
- Corrosion-inhibiting oil content
- Antifreeze (corrosion-inhibiting) concentration
- Determination of the water-soluble corrosion inhibitor content

Orders for freshwater and coolant analysis may be placed with MTU. Samples of min. 0.25 l must be supplied.

As an additional exhaust gas cooler is installed in the Series 4000-04 and the cooling system is more sensitive, a regular check of the coolant is very important for trouble-free engine operation. This check must be carried out annually or after 3000 operating hours and every time the coolant is filled.
The concentration, pH value and silicium content (only with coolant that contain Si) must be within the values specified in the MTU Fluids and Lubricants Specifications.

Permissible concentrations

	Min. % by vol.	Max. % by vol.
Emulsifiable corrosion-inhibiting oils	1.0	2.0
Ethylene glycol corrosion-inhibiting antifreeze[1)]	35 Antifreeze protection to approx. – 25 °C	50 Antifreeze protection to approx. – 40 °C
Propylene glycol corrosion-inhibiting antifreeze	35 Antifreeze protection to approx. – 18 °C	50 Antifreeze protection to approx. -32 °C
BASF G206	35 Antifreeze protection to approx. -18 °C	65 Antifreeze protection to approx. -65 °C

Table 17:

[1)] = deviating application approvals are specified in the comments field of the coolant brands listed in chapter 9 (→ Page 117).

Operational monitoring of permissible concentrations, water-soluble corrosion inhibitors

Permissible concentration range	Manufacturer	Brand name	Reading on hand refractometer[1] at 20 °C (= degrees Brix)					
		% by vol.	7	8	9	10	11	12
9 - 11% by volume	MTU Friedrichshafen	Coolant CS 100 Corrosion Inhibitor Concentrate	3.5	4.0	4.5	5.0	5.5	6.0
		Coolant CS 10/90 Corrosion Inhibitor Premix	3.5	4.0	4.5	5.0	5.5	6.0
	MTU America	Power Cool® Plus 6000	3.5	4.0	4.5	5.0	5.5	6.0
	Arteco	Freecor NBI	Please use test kit of manufacturer					
	BASF SE	Glysacorr G93-94	3.5	4.0	4.5	5.0	5.5	6.0
	BP Lubricants	Castrol Extended Life Corrosion Inhibitor	4.9	5.6	6.3	7.0	7.7	8.4
	CCI Corporation	A 216	4.9	5.6	6.3	7.0	7.7	8.4
	CCI Manufacturing IL Corporation	A 216	4.9	5.6	6.3	7.0	7.7	8.4
	Chevron	Texcool A -200	Please use test kit of manufacturer					
	Detroit Diesel Corporation	Power Cool Plus 6000	4.9	5.6	6.3	7.0	7.7	8.4
	Drew Marine	Drewgard XTA	3.5	4.0	4.5	5.0	5.5	6.0
	ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	4.9	5.6	6.3	7.0	7.7	8.4
	Ginouves	York 719	3.5	4.0	4.5	5.0	5.5	6.0
	Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	4.9	5.6	6.3	7.0	7.7	8.4
	Valvoline	Zerex G-93	3.5	4.0	4.5	5.0	5.5	6.0
7 - 11% by volume	Arteco	Havoline Extended Life Corrosion Inhibitor XLI [EU 32765]	2.6	3.0	3.4	3.7	4.1	4.4
	Nalco	Alfloc (Maxitreat) 3443	1.75	2.0	2.25	2.5	2.75	3.0
		Alfloc (Maxitreat) 3477	1.75	2.0	2.25	2.5	2.75	3.0
	Total	WT Supra	2.6	3.0	3.4	3.7	4.1	4.4
5 - 6 % by vol.	Fleetguard	DCA-4L	Please use test kit of manufacturer					
	Detroit Diesel Corporation	Power Cool 3000						
	Penray	Pencool 3000						

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Permissible concentration range	Manufacturer	Brand name	Reading on hand refractometer[1] at 20 °C (= degrees Brix)					
		% by vol.	7	8	9	10	11	12
3 - 4 % by vol.	Detroit Diesel Corporation	Power Cool 2000	Please use test kit of manufacturer					
	Nalco	Alfloc 2000						
		Nalco 2000						
		Nalcool 2000						
		Trac 102						
	Penray	Pencool 2000						

Table 18:

[1] = concentration determination by means of suitable hand refractometer

Calibrate the hand refractometer with clean water at coolant temperature. Coolant temperature should be 20 °C. Observe the specifications of the manufacturer.

Operational monitoring of permissible concentrations, corrosion-inhibiting antifreeze on ethylene glycol basis

The concentration is determined using a suitable glycol refractometer and direct reading of the scale value in % by vol.

Calibration table for corrosion-Inhibiting antifreezes for special applications

Reading on hand refractometer at 20 °C (= degrees Brix)		Corresponds to a concentration of
I. Propylene glycol corrosion-inhibiting antifreeze	II. BASF G206	
26.3	24.8	35% by volume
26.9	25.5	36% by volume
27.5	26.1	37% by volume
28.2	26.7	38% by volume
28.8	27.4	39% by volume
29.5	28.0	40% by volume
30.1	28.6	41% by volume
30.8	29.2	42% by volume
31.3	29.8	43% by volume
31.9	30.4	44% by volume
32.5	30.9	45% by volume
33.1	31.5	46% by volume
33.7	32.1	47% by volume
34.2	32.6	48% by volume
34.8	33.2	49% by volume
35.3	33.8	50% by volume
	34.4	51% by volume

Reading on hand refractometer at 20 °C (= degrees Brix)		
I. Propylene glycol corrosion-inhibiting antifreeze	II. BASF G206	Corresponds to a concentration of
	34.9	52% by volume
	35.5	53% by volume
	36.1	54% by volume
	36.7	55% by volume
	37.2	56% by volume
	37.8	57% by volume
	38.3	58% by volume
	38.9	59% by volume
	39.4	60% by volume
	39.9	61% by volume
	40.5	62% by volume
	41.0	63% by volume
	41.5	64% by volume
	42.0	65% by volume

Table 19:

5.8 Limit values for coolants

pH value when using:		
– Emulsifiable corrosion inhibiting oil	Min. 7.5	Max. 9.5
– Corrosion inhibitor / Antifreeze	Min. 7.0	Max. 9.0
– Water-soluble corrosion inhibitor for engines with aluminum / light-alloy parts	Min. 7.0	Max. 9.0
– Water-soluble corrosion inhibitor for engines without aluminum / light-alloy parts	Min. 7.0	Max. 11.0
Silicium (valid for coolants containing Si)	Min. 25 mg/l	

Table 20:

The coolant must be changed in case of non-compliance with the above specifications.

Note:

For a holistic appraisal of a coolant function, apart from the above-mentioned limit values the respective coolant-specific characteristic data and the freshwater quality used must be taken into consideration.

5.9 Storage stability of coolant concentrates

The storage stability specification is based on an original sealed and airtight container at a storage temperature of up to max. 30 °C.

Coolant concentrate	Limit value	Brand name / Comments
Emulsifiable corrosion-inhibiting oil	6 months	
Corrosion-inhibiting antifreezes	Approx. 3 years	Observe manufacturer's specifications
Products containing propylene glycol	3 years	BASF G206
Water-soluble corrosion inhibitors	6 months	Nalco Trac 102
	1 year	Detroit Diesel Corp. Power Cool 3000 Penray Pencool 3000
	2 years	Arteco Freecor NBI Chevron Texcool A-200 – Nalco Alfloc 2000 Nalco Nalcool 2000 Nalco Nalco 2000 Detroit Diesel Corp. Power Cool 2000 Penray Pencool 2000
	3 years	BASF Glysacorr G93–94 Drew Marine Drewgard XTA Ginouves York 719 MTU Friedrichshafen Coolant C150 MTU America Power Cool® Plus 6000 Nalco Alfloc (Maxitreat) 3477 Valvoline ZEREX G-93
	5 years	Arteco Havoline Extended Life Corrosion Inhibitor XLI [EU 032765] BP Castrol Extended Life Corrosion Inhibitor CCI Corporation A216 CCI Manufacturing IL A216 Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free [US 236514] Detroit Diesel Corp. Power Cool Plus 6000 ExxonMobil Mobil Delvac Extended Life Corrosion Inhibitor Fleetguard DCA-4L Old World Industries Final Charge Extended Life Corrosion Inhibitor (A216) Total WT Supra

Table 21:

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Note:

For reasons of corrosion protection, do not store in galvanized containers. Take this requirement into account when coolant must be transferred.

Containers must be hermetically sealed and stored in a cool, dry place. Frost protection must be provided in winter.

Further information can be obtained from the product and safety data sheets for the individual coolants.

5.10 Color additives for aqueous corrosion inhibitors and corrosion-inhibiting antifreeze for detection of leaks in the coolant circuit

The following listed fluorescent dyes are approved as additives for aqueous corrosion inhibitors and corrosion-inhibiting antifreeze for the detection of leaks.

Manufacturer	Product name	Part No.	Container size	Storage stability[1)]
Chromatech Inc. Chromatech Europe B.V.	D11014 Chromatint Uranine Conc	X00066947	20 kg	2 years

Table 22:

[1)] = based on original and hermetically sealed containers in frost-free storage (> 5 °C)

Application:

Approx. 40 g dye must be added to 180l coolant.

This dye quantity is already very generous and must not be exceeded.

The fluorescence (yellow color tone) is easily recognizable in daylight. In dark rooms, UV light can be used with a wave length of 365 nm.

6 Fuels

6.1 Diesel fuels - General

Dispose of used fluids and lubricants in accordance with local regulations.
Used oil must never be disposed of via the combustion engine!

Selection of a suitable diesel fuel

The quality of the fuel is very important for satisfactory engine performance, long engine service life and acceptable exhaust emission levels.

Diesel fuels are not available worldwide in the quality required according to (→ Table 23).
The fuel properties depend on many factors, in particular, region, time of year and storage.

Unsuitable fuel usually leads to a reduced service life of engine components and can also cause engine damage.

Further details on fuel qualities, tank care and filtration are available in the publication "Useful information on fuels, tank systems and filtration" (publication number A060631/..).

Fuel values to be observed

		Test methods		Limit values
		ASTM		
Composition				The diesel fuel must be free of inorganic acids, visible water, solid foreign matter and chlorous compounds.
Total contamination (= fuel-insoluble ingredients)	max.	D6217	EN 12662	24 mg/kg
Spec. grav. at 15 °C	min.	D1298 D4052	EN ISO 3675 EN ISO 12185	0.820 g/ml
	max.			0.860 g/ml
API grade at 60 °F	min.	D287		41
	max.			33
Viscosity at 40 °C	min.	D445	EN ISO 3104	1.5 mm²/s
	max.			4.5 mm²/s
Flashpoint (closed crucible)	min.	D93	EN ISO 2719	55 °C (60 °C for SOLAS)[1)]
Boiling curve:		D86	EN ISO 3405	
– Initial boiling point				160 – 220 °C
Recovery at 250 °C	max.			65% by volume
Recovery 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
Proportion of water: (absolute, no free water)	max.	D6304	EN ISO 12937	200 mg/kg

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		Test methods		Limit values
		ASTM		
Carbon residue from 10% distillation residue	max.	D189	EN ISO 10370	0.30% by weight
Oxide ash:		D482	EN ISO 6245	
– Engines without exhaust aftertreatment and DOC-/SCR system	max.			0.01 % by weight (100 mg/kg)
– Engines with exhaust aftertreatment	max.			0.001 % by weight (10 mg/kg)
Sulfur content: – Engines without exhaust aftertreatment – Engines with exhaust aftertreatment	 max. max.	D5453, D2622	EN ISO 20846, EN ISO 20884	 0.5 % by weight (5000 mg/kg) 0.0015 % by weight (15 mg/kg)
Cetane number	min.	D613	EN ISO 5165, EN ISO 15195	45
Cetane index	min.	D976	EN ISO 4264	42
Copper corrosion 3 hrs at 50 °C	Max. degree of corrosion	D130	EN ISO 2160	1 a
Oxidation stability (Rancimat)	min.		EN 15751	20 hours
Oxidation stability	max.	D2274	EN ISO 12205	25 g/m³
Lubricity at 60 °C (HFRR value)	max.	D6079	EN ISO 12156-1	520 µm
Filter plugging point (CFPP)		D6371	DIN EN 116	See Note [2]
Cloud Point		D2500	DIN EN 23015	See Note [3]
Neutralization number	max.	D974		0.2 mgKOH/g

Table 23:

[1] For marine application, a min. flashpoint of 60 °C (Solas = Safety of life at sea) applies.

[2] Filter plugging point or Cold Filter Plugging Point (CFPP) denotes the temperature at which a test filter is blocked under defined conditions by precipitated paraffins. This characteristic is used for diesel fuels as per DIN EN 590 to describe the climatic requirements (e.g. summer and winter diesel).

[3] The cloud point is the temperature at which a liquid product becomes turbid in the test glass due to precipitation of paraffin. This must not be higher than the ambient temperature.

It is the fuel supplier's responsibility to provide a fuel that will assure correct engine operation at the expected minimum temperatures and under the given geographical and other local conditions.

The operating company must ensure that there is always sufficient fuel to meet the corresponding climatic requirements.

Comment: 1 by weight % = 10000 mg/kg = 10000 ppm

Note:

For safe and efficient engine operation, for all permissible fuel qualities the limit values named (→ Table 23), in particular for water, total contamination, must be observed at the interface marked in Fig. 4 item 6 at the latest.

In addition to the limit values named in (→ Table 23), a particle distribution in the fuel according to ISO 4406 must be observed:

Particle distribution	Test method ASTM		Limit values	
			Common rail	conventional injection
Particle distribution for fuel between last tank and prefilter (see Fig. 4 item 5)	D7619	Coding of number of particles as per ISO 4406	max. ISO Code 18/17/14 for 4/6/14 µm particle size	max. ISO Code 21/20/17 for 4/6/14 µm particle size

Table 24:

The limit values named in (→ Table 24) must already be observed in the feed between the last tank before the engine and the prefilter (if necessary, with water separator).

For plants without a prefilter, this refers to the feed between the last tank and the MTU equipment. For the analysis of the fuel quality, an interface (sample extraction cock) must be provided for sample extraction during operation.

For existing without an accessible feed, a sample extraction point in the last tank before the MTU equipment is permissible.

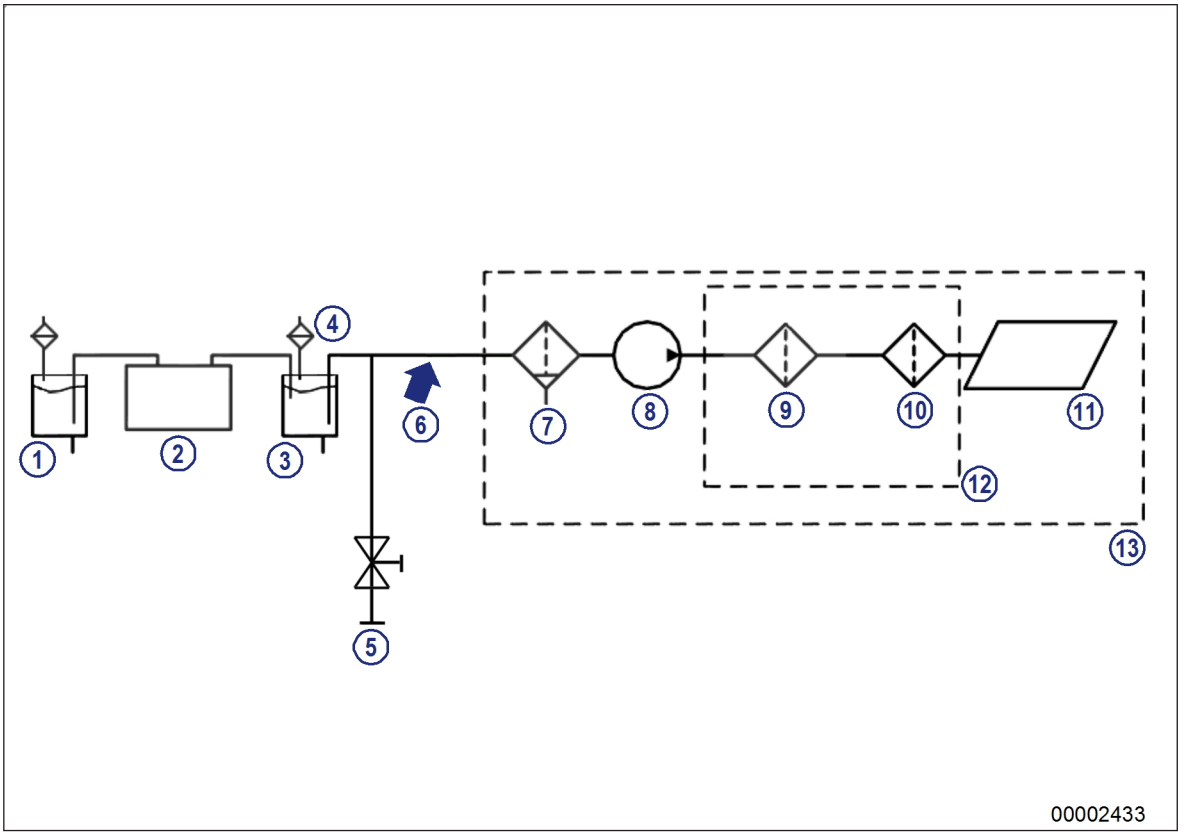

Figure 4:

1 Fuel tank
2 Fuel conditioning (option)
3 Last tank before engine
4 Tank ventilation filter
5 Sample extraction
6 Interface for fuel specification
7 Fuel prefilter with water separator (option)
8 Fuel low-pressure pump
9 Intermediate filter (option)
10 Main filter
11 Injection system
12 Engine filter
13 Engine scope

Note:

With poorer particle distribution, it is necessary to integrate further / more-optimized filter stages in the fuel system to achieve the operational life of fuel filters and components of the injection system.

For the limit values named for the interface, it has been validated that MTU-approved prefilters provide sufficient filtration.

Damage and disadvantages to engine caused by the use of non-MTU-approved fuel qualities in acc. with (→ Table 23) and (→ Table 24) and chapter 6.2 (→ Page 43) or prefilters are not deficiencies that are covered by the warranty from MTU-Friedrichshafen GmbH.

Series-related injection / and exhaust aftertreatment systems

Series	Diesel accumulator injection system (Common rail)	conventional injection systems	Exhaust aftertreatment system	Exhaust gas recirculation
S 60		yes	no	
099		yes	no	no
183		yes	no	no

Series	Diesel accumulator injection system (Common rail)	conventional injection systems	Exhaust aftertreatment system	Exhaust gas recirculation
396 C&I, Genset, Marine, Rail, Submarine		yes	no	no
538 Marine		yes	no	no
595 Marine		yes	no	no
956-01, -02, -03, -04		yes	no	no
1163-01, -02, -03		yes	no	no
1163-04	yes		no	no
2000 Cx0, Cx1, Cx2, Gx3, Gx5, Mx0, Mx1, Px2, Sx0, Sx1, Sx2		yes	no	no
2000 Cx6, Gx6, Gx7, Mx2, Mx3, Mx4, Mx6, Sx6	yes		only Series 2000 Gx7 / Mx6	only Series 2000 Cx6 / Sx6
4000-00, -01, -02, -03, -04	yes		only Series 4000 Rx4	only Series 4000 Cx4 / Cx5 / Rx4 / T94 / T95
8000	yes		no	no
Two-cycle engines		yes	no	no

Table 25:

Emission certification

For engines with exhaust aftertreatment certified for EPA Tier 4i or Tier 4 and EU IIIb, fuel in accordance with DIN EN 590:2014-04 and ASTM D 975-14 Grade1-D S15 and Grade 2-D S15 are permitted.

Laboratory analysis

An order for fuel analysis can be placed with MTU.

The following data is required:
- Fuel specifications
- Sampling point
- Serial number of engine from which fuel sample was taken

Submit the following:
- 0.5 liters of fuel
- 1.5 liters of fuel (with additional determination of cetane number)

6.2 Series-based diesel fuel approvals for MTU engines

Commercially available diesel fuels meeting the following specifications are approved for use:

Distillate fuels

DIN EN 590 and ASTM D975

New series

Fuel specifications Restrictions Series	DIN EN 590: 2014-4 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 2-D S 15, S 500, S 5000
S 60	Approval issued	Approval issued	Approval issued
2000 CR	Approval issued	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg (CR, Mx6 with SCR) - sulfur content max. 500 mg/kg (PLD, MX6 without SCR)	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg (CR, Mx6 with SCR) - sulfur content max. 500 mg/kg (PLD, Mx6 without SCR)
2000 Cx6, Gx6, Gx7, Mx6, Sx6	Approval issued		
2000 PLD	Approval issued		
4000-00	Approval issued	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-01	Approval issued		
4000-02	Approval issued		
4000-03 C, G, P, R, S	Approval issued		
4000 M23F, M23S	Approval issued		
4000 M33F, M33S	Approval issued		
4000 M53, M53R	Approval issued		
4000 M63, M63L	Approval issued		
4000 M53B, M73 - M93L, N43S, N83	Approval issued		
4000-04 M	Approval issued		

Fuel specifications Restrictions Series	DIN EN 590: 2014-4 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 2-D S 15, S 500, S 5000
4000 T94, T94L	Approval issued	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg
4000 R54, R64, R74, R84	Approval issued		
4000 C64	Approval issued		
8000	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg - viscosity min. 1.5 mm^2/s	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg

Table 26:

Classic series

Fuel specifications Restrictions Series	DIN EN 590: 2014-04 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 2-D S 15, S 500, S 5000
099	Approval issued	Approval issued	Approval issued
183	Approval issued	Approval issued	Approval issued
396 C&I, Genset, Marine, Rail, Submarine	Approval issued	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42	Approval issued if: - cetane number min. 45 or - cetane index min. 42

Fuel specifications Restrictions Series	DIN EN 590: 2014-04 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 2-D S 15, S 500, S 5000
538 Marine 595 Marine	Approval issued Anti-wear additive necessary	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg
956 TB31, TB32, TB33 956 TB34 Nuclear power station, emergency power	Approval issued Anti-wear additive necessary	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg
956-01 Marine / Rail 956-02 Marine	Approval issued Anti-wear additive necessary	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg
1163 TB32 Genset	Approval issued Anti-wear additive necessary	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg
1163-02 Marine 1163-03 Marine	Approval issued Anti-wear additive necessary	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg
1163-04 Marine	Approval issued	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42	Approval issued if: - viscosity min. 1.5 mm^2/s - cetane number min. 45 or - cetane index min. 42

Table 27:

Two-cycle engines

Fuel specifications Restrictions Series	DIN EN 590: 2014-04 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	ASTM D975-14a Grade 2-D S 15, S 500, S 5000
S53, S71, S92, S149	Approval issued	Approval issued if: - lubricity max. 460 µm	Approval issued if: - lubricity max. 460 µm

Table 28:

British Standard 2869

New series

Fuel specifications Restrictions Series	BS 2869:2010 Part 1 Class A2 - SOLAS: Flashpoint min. 60 °C - Density: max. 860 kg/m³ - Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required - With exhaust aftertreatment: Sulfur content: max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	BS 2869:2010 Part 2 Class D
S 60	Approval issued	Approval issued
2000 CR	No approval	No approval
2000 Cx6, Gx6, Gx7, Mx6, Sx6		
2000 PLD		
4000-00	Approval issued	Approval issued
4000-01		
4000-02		
4000 C, G, P, R, S		
4000 M23F, M23S		
4000 M33F, M33S		
4000 M53, M53R		
4000 M63, M63L		
4000 M53B, M73 - 93L, N43S, N83		
4000-04 M		

TIM-ID: 0000057587 - 002

Fuel specifications Restrictions Series	BS 2869:2010 Part 1 Class A2 - SOLAS: Flashpoint min. 60 °C - Density: max. 860 kg/m³ - Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required - With exhaust aftertreatment: Sulfur content: max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	BS 2869:2010 Part 2 Class D
4000 T94, T94L	Approval issued if: - sulfur content max. 15 mg/kg	Approval issued if: - sulfur content max. 15 mg/kg
4000 R54, R64, R74, R84		
4000 C64		
8000	Approval issued	Approval issued if: - sulfur content max. 50 mg/kg

Table 29:

Classic series

Fuel specifications Restrictions Series	BS 2869:2010 Part 1 Class A2 - SOLAS: Flashpoint min. 60 °C - Density: max. 860 kg/m³ - Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required - With exhaust aftertreatment: Sulfur content: max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	BS 2869:2010 Part 2 Class D
099	Approval issued	Approval issued
183	Approval issued	Approval issued
396 C&I, Genset, Marine, Rail, Submarine	Approval issued	Approval issued
538 Marine	Approval issued Anti-wear additive necessary	Approval issued if: - sulfur content min. 500 mg/kg
595 Marine		
956 TB31, TB32, TB33 956 TB34 Nuclear power station, emergency power	No approval	No approval
956-01 Marine / Rail	Approval issued Anti-wear additive necessary	Approval issued if: - sulfur content min. 500 mg/kg
956-02 Marine		
1163-02 TB32 Genset	No approval	No approval
1163-02 Marine	Approval issued Anti-wear additive necessary	Approval issued if: - sulfur content min. 500 mg/kg
1163-03 Marine		
1163-04 Marine	Approval issued	Approval issued

Table 30:

Two-cycle engines

Fuel specifications	BS 2869:2010 Part 1 Class A2	BS 2869:2010 Part 2 Class D
Restrictions	- SOLAS: Flashpoint min. 60 °C - Density: max. 860 kg/m³ - Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required - With exhaust aftertreatment: Sulfur content: max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	
Series		
S53, S71, S92, S149	Approval issued if: - lubricity max. 460 µm	Approval issued if: - lubricity max. 460 µm

Table 31:

Heating oil

New series

Fuel specifications	DIN 51603-1:2011-09		DIN 51603-6:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- Solas: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
S60	Approval issued	Approval issued	No approval
2000 CR	No approval	Approval issued if: - sulfur content max. 15 mg/kg	No approval
2000 Cx6, Gx6, Gx7, Mx6, Sx6			
2000 PLD	Approval issued if: - density at 15 °C min. 0.820g/ml - sulfur content max. 50 mg/kg	Approval issued	No approval
4000-00	Approval issued	Approval issued	No approval
4000-01	Approval issued	Approval issued	No approval
4000-02	Approval issued	Approval issued	No approval
4000-03 C, G, P, R, S	Approval issued	Approval issued	No approval
4000 M23F, M23S	Approval issued	Approval issued	No approval
4000 M33F, M33S			
4000 M53, M53R			
4000 M63, M63L			

Fuel specifications	DIN 51603-1:2011-09		DIN 51603-6:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- Solas: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
4000 M53B, M73 - 93L, N43S, N83	Approval issued	Approval issued	No approval
4000-04 M	Approval issued	Approval issued	No approval
4000 T94, T94L	No approval	Approval issued if: - sulfur content max. 15 mg/kg	No approval
4000 R54, R64, R74, R84			
4000 C64			
8000	Approval issued	Approval issued	No approval

Table 32:

Classic series

Fuel specifications	DIN 51603-1:2011-09		DIN 51603-6:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- Solas: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
099	Approval issued	Approval issued	No approval
183	Approval issued	Approval issued	No approval
396 C&I, Genset, Marine, Rail, Submarine	Approval issued	Approval issued	No approval
538 Marine	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary	No approval
595 Marine			
956 TB31, TB32, TB33 956 TB34 Nuclear power station, emergency power	Approval issued if: Heating oils EL standard and low-sulfur according to DIN 51603-1 must only be used if all requirements in acc. with Heating oil EL (→ Page 69) have been met.		No approval

Fuel specifications	DIN 51603-1:2011-09		DIN 51603-6:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- Solas: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
956-01 Marine / Rail	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary	No approval
956-02 Marine			
1163-02 TB32 Genset	Approval issued if: Heating oils EL standard and low-sulfur according to DIN 51603-1 must only be used if all requirements in acc. with Heating oil EL (→ Page 69) have been met.		No approval
1163-02 Marine	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary	No approval
1163-03 Marine			
1163-04 Marine	Approval issued	Approval issued	No approval

Table 33:

Two-cycle engines

Fuel specifications	DIN 51603-1:2011-09		DIN 51603-6:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- Solas: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
S53, S71, S92, S149	No approval	No approval	No approval

Table 34:

Marine distillate fuels in accordance with ISO 8217:2013-12

New series

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2013-12			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)			
Series				
S60	Approval issued	No approval	No approval	No approval
2000 CR	No approval	No approval	No approval	No approval
2000 Cx6, Gx6, Gx7, Mx6, Sx6				
2000 PLD				
4000-01	Approval issued if: Viscosity > 4.5 mm^2/s: • Preheating required	Approval issued if: Viscosity > 4.5 mm^2/s: • Preheating required - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42		No approval
4000-02				
4000-03 C, G, P, R, S				
4000 M23F, M23S	Approval issued if: - viscosity > 4.5 mm^2/s: • Preheating required	Approval issued if: - viscosity > 4.5 mm^2/s: • Preheating required - suitable filter system is used Except for area of application of EPA Tier 2		No approval
4000 M33F, M33S				
4000 M53, M53R				
4000 M63, M63L				
4000 M53B, M73-M93L, N43S, N83	Approval issued if: - viscosity > 4.5 mm^2/s: • Preheating required	Approval issued if: - viscosity > 4.5 mm^2/s: • Preheating required - suitable filter system is used - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 Except for area of application of EPA Tier 2		No approval
4000-04 M	No approval	No approval	No approval	No approval

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2013-12			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)			
Series				
4000 T94, T94L	No approval	No approval	No approval	No approval
4000 R54, R64, R74, R84				
4000 C64				
8000	Approval issued if: - viscosity > 4.5 mm^2/s: • Preheating required - sulfur content max. 50 mg/kg	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s - viscosity > 4.5 mm^2/s: • Preheating required - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42		No approval

Table 35:

Classic series

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2013-12			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)			
Series				
099	Approval issued	upon request	upon request	No approval
183	Approval issued	upon request	upon request	No approval
396 C&I, Genset, Marine, Rail, Sub-marine	Approval issued if: - sulfur content max. 0.5% (5000 mg/kg)	upon request	upon request	No approval
538 Marine	Approval issued if: - sulfur content max. 0.5% (5000 mg/kg)	upon request	upon request	No approval

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2013-12			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)			
Series				
595 Marine	Approval issued if: - sulfur content max. 0.5% (5000 mg/kg)	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%		No approval
956 TB31, TB32, TB33 956 TB34 Nuclear power station, emergency power	No approval	No approval	No approval	No approval
956-01 Marine / Rail 956-02 Marine	Approval issued if: - sulfur content max. 0.5% (5000 mg/kg)	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%		No approval
1163-02 TB32 Genset	No approval	No approval	No approval	No approval
1163-02 Marine 1163-03 Marine	Approval issued if: - sulfur content max. 0.5% (5000 mg/kg)	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%		No approval
1163-04 Marine	Approval issued if: - sulfur content max. 0.5% (5000 mg/kg)	Approval issued if: - viscosity 1.5 to 4.5 mm^2/s - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - suitable filter system is used - sulfur content max. 0.5%		No approval

Table 36:

Two-cycle engines

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2013-12			
	DMX	DMA	DMZ	DMB
Series				
S53, S71, S92, S149	No approval	No approval	No approval	No approval

Table 37:

Aviation turbine fuel

New series

Fuel specifications	F-34 / F-35 JP-8	F-44 JP-5	F-63 in accordance with DCSEA 108/A
Restrictions			
Series			
S60	Generally not approved, approval upon request		
2000 CR	Generally not approved, approval upon request		
2000 Cx6, Gx6, Gx7, Mx6, Sx6			
2000 PLD			
4000-01	Generally not approved, approval upon request		Approval issued for: 4000-03 G
4000-02			
4000-03 C, G, P, R, S			
4000 M23F, M23S	Generally not approved, approval upon request		
4000 M33F, M33S			
4000 M53, M53R			
4000 M63, M63L			
4000 M53B, M73 - M93L	Generally not approved, approval upon request		
4000-04 M	Generally not approved, approval upon request		
4000 T94, T94L	Generally not approved, approval upon request		
4000 R54, R64, R74, R84			
4000 C64	Generally not approved, approval upon request		
8000	Generally not approved		

Table 38:

Classic series

Fuel specifications	F-34 / F-35 JP-8	F-44 JP-5	F-63 in accordance with DCSEA 108/A
Restrictions			
Series			
099	Generally not approved, approval upon request		
183	Generally not approved, approval upon request		

Fuel specifications Restrictions Series	F-34 / F-35 JP-8	F-44 JP-5	F-63 in accordance with DCSEA 108/A
396 C&I, Genset, Marine, Rail, Submarine	Generally not approved, approval upon request		
538 Marine	Generally not approved, approval upon request		
595 Marine			
956 TB31, TB32, TB33 956TB34 Nuclear power station, emergency power	Generally not approved		
956-01 Marine / Rail	Generally not approved, approval upon request		
956-02 Marine			
1163-02 TB32 Genset	Generally not approved		
1163-02 Marine	Generally not approved, approval upon request		Approval issued
1163-03 Marine			
1163-04 Marine	Generally not approved, approval upon request		Approval issued

Table 39:

Two-cycle engines

Fuel specifications Series	F-34 / F-35 JP-8	F-44 JP-5	F-63 in accordance with DCSEA 108/A
S53, S71, S92, S149	Generally not approved		

Table 40:

NATO diesel fuels

Diesel fuel NATO Code F-54

New series

Fuel specifications Restrictions Series	NATO Code F-54 in accordance with TL 9140-0001 Edition 8 Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F-54 in accordance with STANAG 7090 Edition 4 Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Density: min. 0.820 g/ml - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
S60	Approval issued	Approval issued
2000 CR	Approval issued if: - sulfur content max. 15 mg/kg	Approval issued if: - sulfur content max. 15 mg/kg
2000 Cx6, Gx6, Gx7, Mx6, Sx6		
2000 PLD	Approval issued	Approval issued
4000-00	Approval issued	Approval issued
4000-01		
4000-02		
4000-03 C, G, P, R, S		
4000 M23F, M23S	Approval issued	Approval issued
4000 M33F, M33S		
4000 M53, M53R		
4000 M63, M63L		
4000 M53B, M73 - 93L, N43S, N83	Approval issued	Approval issued
4000-04 M	Approval issued	Approval issued
4000 T94, T94L	Approval issued if: - sulfur content max. 15 mg/kg	Approval issued if: - sulfur content max. 15 mg/kg
4000 R54, R64, R74, R84		
4000 C64		
8000	Approval issued if: - sulfur content max. 50 mg/kg	Approval issued

Table 41:

Diesel fuel NATO Code F-75

New series

Fuel specifications Comments Restrictions Series	NATO Code F 75 TL 9140-0003 - Reduced power possible due to min. density of 0.815 g/ml - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F 75 STANAG 1385 - Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0 % → Adapt oil and oil change interval - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
S60	No approval	No approval
2000 CR	No approval	No approval
2000 Cx6, Gx6, Gx7, Mx6, Sx6		
2000 PLD		
4000-00	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-01		
4000-02		
4000-03 C, G, P, R, S		
4000 M23F, M23S	Approval issued	Approval issued
4000 M33F, M33S		
4000 M53, M53R		
4000 M63, M63L		
4000 M 53B, M73 - 93L, N43S, N83	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-04 M	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000 T94, T94L	No approval	No approval
4000 R54, R64, R74, R84		
4000 C64		
8000	Approval issued if: - sulfur content max. 50 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg

Table 42:

Diesel fuel NATO Code F-76

New series

Fuel specifications	NATO Code F 76 STANAG 1385 Edition 6	NATO Code F 76 DEF-STAN 91-4 Edition 8	NATO Code F 76 MIL-DTL-16884N
Restrictions	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
S60	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued
2000 CR	No approval	No approval	No approval
2000 Cx6, Gx6, Gx7, Mx6, Sx6			
2000 PLD			
4000-00	Approval issued if: - cetane number min. 45 or - cetane index min. 42	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-01			
4000-02			
4000-03 C, G, P, R, S			
4000 M23F, M23S	Approval issued	Approval issued	Approval issued
4000 M33F, M33S			
4000 M53, M53R			
4000 M63, M63L			
4000 M53B, M73 - M93L, N43S, N83	Approval issued if: - cetane number min. 45 or - cetane index min. 42	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-04 M	Approval issued if: - cetane number min. 45 or - cetane index min. 42	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000 T94, T94L	No approval	No approval	No approval
4000 R54, R64, R74, R84			
4000 C64			
8000	Approval issued if: - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg	Approval issued if: - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg	Approval issued if: - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg

Table 43:

NATO diesel fuels

Diesel fuels Nato Code F-54

Classic series

Fuel specifications Restrictions Series	NATO Code F-54 in accordance with TL 9140-0001 Edition 8 Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F-54 in accordance with STANAG 7090 Edition 4 Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Density: min. 0.820 g/ml - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
099	Approval issued	Approval issued
183	Approval issued	Approval issued
396 C&I, Genset, Marine, Rail, Submarine	Approval issued	Approval issued
538 Marine 595 Marine	Approval issued Anti-wear additive necessary if sulfur content max. 50 mg/kg	Approval issued Anti-wear additive necessary
956 TB 31, TB32, TB33 956 TB34 Nuclear power station, emergency power	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary
956-01 Marine / Rail 956-02 Marine	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary
1163-02 TB32 Genset	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary
1163-02 Marine 1163-03 Marine	Approval issued Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary
1163-04 Marine	Approval issued	Approval issued

Table 44:

Diesel fuel NATO Code F-75

Classic series

Fuel specifications Comments Restrictions Series	NATO Code F 75 TL 9140-0003 - Reduced power possible due to min. density of 0.815 g/ml - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F 75 STANAG 1385 - Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0 % → Adapt oil and oil change interval - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
099	Approval issued	upon request
183	Approval issued	upon request
396 C&I, Genset, Marine, Rail, Submarine	Approval issued	upon request
538 Marine	Approval issued	upon request
595 Marine	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 % and min. 0.05 %
956 TB31, TB32, TB33 956 TB34 Nuclear power station, emergency power	No approval	No approval
956-01 Marine / Rail	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 % and min. 0.05 %
956-02 Marine		
1163-02 TB32 Genset	No approval	No approval
1163-02 Marine	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 % and min. 0.05 %
1163-03 Marine		
1163-04 Marine	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 %

Table 45:

Diesel fuel NATO Code F-76

Classic series

Fuel specifications	NATO Code F 76 STANAG 1385 Edition 6	NATO Code F 76 DEF-STAN 91-4 Edition 8	NATO Code F 76 MIL-DTL-16884N
Restrictions	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
Series			
099	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued
183	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued
396 C&I, Genset, Marine, Rail, Submarine	upon request	Approval issued if: - density 0.820 to 0.860 g/ml	upon request
538 Marine	upon request	Approval issued	upon request
595 Marine	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 % Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg
956 TB31, TB32, TB33 956 TB34 Nuclear power station, emergency power	No approval	No approval	No approval
956-01 Marine / Rail	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 % Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml Anti-wear additive necessary if sulfur content max. 500 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 500 mg/kg
956-02 Marine			
1163-02 TB32 Genset	No approval	No approval	No approval

Fuel specifications Restrictions Series	NATO Code F 76 STANAG 1385 Edition 6	NATO Code F 76 DEF-STAN 91-4 Edition 8	NATO Code F 76 MIL-DTL-16884N
	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
1163-02 Marine	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 %	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 % and min. 0.05 %
1163-03 Marine			
1163-04 Marine	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 %	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42

Table 46:

– Other qualities on request

Diesel fuel NATO Code F-54

Two-cycle engines

Fuel specifications Restrictions Series	NATO Code F-54 in accordance with TL 9140-0001 Edition 8	NATO Code F-54 in accordance with STANAG 7090 Edition 4
	Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 - Density: min. 0.820 g/ml - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
S53, S71, S92, S149	Approval issued if lubricity max. 460 µm	

Table 47:

Diesel fuel NATO Code F-75

Two-cycle engines

Fuel specifications Comments Restrictions Series	NATO Code F 75 TL 9140-0003 - Reduced power possible due to min. density of 0.815 g/ml - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)	NATO Code F 75 STANAG 1385 - Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0 % → Adapt oil and oil change interval - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)
S53, S71, S92, S149	No approval	No approval

Table 48:

Diesel fuel NATO Code F-76

Two-cycle engines

Fuel specifications Restrictions Series	NATO Code F 76 STANAG 1385 Edition 6	NATO Code F 76 DEF-STAN 91-4 Edition 8	NATO Code F 76 MIL-DTL-16884N
	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - With exhaust aftertreatment: Sulfur content max. 15 mg/kg - Particle distribution for fuel in acc. with table 24 (→ Page 38)		
S53, S71, S92, S149	No approval	No approval	No approval

Table 49:

– Other qualities on request

6.3 Diesel fuels for engines with exhaust aftertreatment

Engines with exhaust aftertreatment place special demands on the fuels used to guarantee the operational reliability and service life of the exhaust system and the engine.

Depending on the technology used for exhaust aftertreatment, the following fuels can be used.

Exhaust gas technology	Technical approval for					
	DIN EN 590:2014-04	ASTM D975-14a Grade 1-D	ASTM D975-14a Grade 2-D	DMX in accordance with DIN ISO 8217:2013-12	DMA in accordance with DIN ISO 8217:2013-12	Heating oil in accordance with DIN 51603-6:2011-09 EL low-sulfur
Restrictions:						
Oxidation catalyst DOC (without particulate filter)	No restriction	S15	S15	No approval	No approval	No approval
Particle oxidation catalyst (POC)	Ash <10 mg/kg	S15 Ash <10 mg/kg	S15 Ash <10 mg/kg	No approval	No approval	No approval
SCR system with vanadium catalysts (no particulate filter)	No restriction	S15 S<500 mg/kg with individual case approval	S15 S<500 mg/kg with individual case approval	Individual case approval		
SCR system with zeolith catalysts (no particulate filter)	No restriction	S15	S15	No approval	No approval	No approval
Diesel particulate filter (DPF)	Ash <10 mg/kg	S15 Ash <10 mg/kg	S15 Ash <10 mg/kg	Individual case approval		No approval
Combination system SCR+ particulate filter	Ash <10 mg/kg	S15 Ash <10 mg/kg	S15 Ash <10 mg/kg	Individual case approval		No approval

Table 50:

If the specifications from the tables are not observed, the prescribed TBO can not be guaranteed.

Warranty claim cases that result from the use of an impermissible fuel quality shall be rejected.

If a fuel is present that does not comply with MTU specifications, in certain circumstances MTU can assist in the selection of corresponding improvement measures.

Any possible restrictions related to engine requirements must also be observed.

Diesel fuel with a proportion of biodiesel (FAME, fatty acid methyl ester) of max. 7% in accordance with DIN EN 590:2014-04 may be used. The use of fuels with an increased proportion of biodiesel is not permitted for plants with exhaust aftertreatment because trace elements they may contain can act as catalyst poisons and lead to filter obstructions.

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For engines with exhaust aftertreatment certified for EPA Tier 4i or Tier 4 and EU IIIb, fuel in accordance with DIN EN 590:2014-04 and ASTM D 975-14 Grade 1-D S15 and Grade 2-D S15 are permitted.

Commercially available diesel fuels normally contain considerably less ash-forming agents that those certified by the relevant standards (typical ash content max. 0.001 % = 10 mg/kg). The particulate filters are designed for these low loads accordingly because the exhaust system would otherwise be completely overdimensioned. The maximum ash content in fuel specified by MTU has been defined to ensure that the particulate filter reaches the assured service life without the back pressure of the filter becoming too high for the engine.

The use of fuel additives for minimizing wear is not permitted on plants with exhaust aftertreatment!

Use of fuel additives for lowering soot regeneration temperature on plants with soot filter

Fuel additives for lowering the soot regeneration temperature (FBC, fuel borne catalyst) are generally not approved. The exhaust aftertreatment systems from MTU are designed such that soot regeneration takes place without additives.

6.4 Biodiesel - biodiesel admixture

The standardized general term "FAME" (fatty acid methyl ester) is used here to designate biodiesel fuels.

General information

- 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.

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 non-compliance with our specifications on operation using FAME. All resultant irregularities and consequential damage lie outside our responsibility.

Use of B20 fuels

Information on the use of B20 fuels is provided in the publication A060632/.. .

The following engines are approved/not approved for operation with 100% FAME in compliance with DIN EN 14214:2014-06.

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

Series	Approved / Not approved	Conversion necessary
SUN	No approval	
700	No approval	
750	No approval	
OM 457 LA	From series introduction	No
460	From series introduction	No
900	From series introduction	No
500	From series introduction	No
S 40	No approval	
S 50	No approval	
S 60	No approval	
183	No approval	
2000	No approval	
396	No approval	
4000	No approval	
538	No approval	
595	No approval	
956	No approval	

Series	Approved / Not approved	Conversion necessary
1163	No approval	
8000	No approval	

Table 51:

Diesel fuel with a FAME content of max. 7% in compliance with DIN EN 590-04 may be used. Such fuel may also be used in engines which have not been approved for operation with FAME, without affecting oil drain intervals.

Fuel

- The fuel must comply with DIN EN 14214:2014-06. 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 MTU Fluids and Lubricants Specifications. Engine oils in accordance with Sheet 228.3 or Oil Category 2 as per MTU 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.
- For this reason, engine oil and filter change intervals must be shortened for operation both with pure FAME and with FAME-diesel mixtures.
- 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 52). 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 52:

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.
- Fuel and engine oil must be changed approximately 25 operating hours after conversion to FAME due to the danger of blockage caused by loosened deposits (FAME has a pronounced cleaning effect).
- 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%–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. For flushing, the engine must be operated for at least 30 minutes on FAME-free diesel fuel.

Vegetable oils as an alternative to diesel fuel

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

Diesel fuels in winter operation

At low outdoor temperatures, the diesel fuel's fluidity can be inadequate on account of paraffin precipitation.

In order to prevent operational problems (e.g. clogged filters) during the winter months, diesel fuel with suitable cold-flow characteristics is available on the market. Deviations are possible during transitional periods and in individual countries.

6.5 Heating oil EL

Heating oil differs from diesel fuel mainly because of the following non-specified characteristics:

– Cetane number

– Sulfur content

– Oxidation stability

– Corrosion effect on copper

– Lubricity

– Low temperature behavior

If the heating requirements comply with the specifications of the diesel fuel DIN EN 590:2014-04 (summer and winter quality), there are no technical reasons why it can not be used in the diesel engine

6.6 Supplementary fuel additives

Supplementary fuel additives

The engines are designed such that satisfactory operation with normal, commercially available fuels is ensured. Many of these fuels already contain performance-enhancing additives.

The additives are added by the supplier as the agent responsible for product quality.

The anti-wear additives and biocides represent an exception(→ Page 70).

Attention is drawn to the fact that the use of diesel fuels or additives other than those stipulated in the MTU Fluids and Lubricants Specifications is always the responsibility of the operator.

Diesel fuels with sulfur content < 500 mg/kg

On Series 362, 396, 538, 652, 595, 956, 1163-02 and 03 engines with cylinder heads not fitted with valve seat inserts, the use of low-sulfur fuel (< 500 mg/kg) can lead to increased valve seat wear. This wear can be reduced by the addition of anti-wear additives. The approve supplmentary additives must be added to the fuel in the specified concentration. The additive must be filled before every refueling.

Microorganisms in fuel

Bacterial attack and sludge formation may occur in the fuel under unfavorable conditions. In such cases, the fuel must be treated with biocides in accordance with the manufacturer's specifications. Overconcentration must always be avoided.

The biocides approved at MTU are listed in the table.

Approved anti-wear additives

Manufacturer	Brand name	Concentration for use
The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092 USA Tel. 01 440-943-4200	ADX 766 M	250-350 mg/kg
Tunap Industrie GmbH Bürgermeister-Seidl-Str. 2 82515 Wolfratshausen Tel. +49 (0) 8171 1600-0 Fax. +49 (0) 8171 1600-91	Tunadd PS	250-350 mg/kg

Table 53:

The use of fuel additives for minimizing wear is not permitted on engine/plants with exhaust aftertreatment!

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Approved biocides

Manufacturer	Brand name	Concentration for use
ISP Biochema Schwaben GmbH Ashland Specialty Ingredients Luitpoldstrasse 32 87700 Memmingen Tel. +49 (0)8331 9580 0 Fax. +49 (0)8331 9580 51	Bakzid	100 ml / 100 l
Maintenance Technologies Paddy's Pad 1056 CC t/a Maintenance Technologies Tel. +27 21 786 4980 Cell +27 82 598 6830	Dieselcure Fuel Decontainment	1 : 1200 (833 mg/kg)
Adolf Würth GmbH & Co. KG Reinhold Würth-Straße 12-17 74653 Künzelsau Tel. +49 (0) 7940 15-2248	Dieselcure Fuel Decontainment	1 : 1200 (833 mg/kg)
Schülke und Mayr 22840 Norderstedt Tel. +49 (0) 40 52100-00 Fax. +49 (0) 40 52100-244	grotamar 71 grotamar 82 StabiCor 71	0.5 l / ton 1.0 l / 1000 l 0.5 l / ton
Supafuel Marketing CC PO Box 1167 Allens Nek 1737 Johannesburg South Africa Tel. +27 83 6010 846 Fax. +27 86 6357 577	Dieselfix / Supafuel	1:1200 (833 mg/kg)
Wilhelmsen Ships Service AS Willem Barentszstraat 50 3165 AB Rotterdam-Albrtandswaard Tel. +31 10 487 7777 Fax. +31 10 487 7888 Netherlands	Biocontrol MAR 71	333 ml / drum

Table 54:

Flow improvers

Flow improvers cannot prevent paraffin precipitation but they do influence the size of the crystals and allow the diesel fuel to pass through the filter.

The effectiveness of the flow improvers is not guaranteed for every fuel.

Certainty is only assured after laboratory testing of the filtering capability.

Required quantities and mixing procedures must be carried out according to the manufacturer's instructions.

6.7 Unsuitable materials in the diesel fuel circuit

Components made of copper and zinc materials

The use of components made of copper and zinc materials in the fuel circuit is prohibited. They can cause chemical reactions in the fuel and thus lead to formation of a coating in the fuel system.

Requirements

Based on current knowledge, the following materials and coatings must not be used in a diesel fuel circuit because negative mutual reactions can occur even with approved coolant additives.

Metallic materials

- Zinc, also as surface protection
- Zinc-based alloys
- Copper
- Copper-based alloys with the exception of CuNi10 and CuNi30 (seawater cooler)
- Tin, also as surface protection
- Magnesium-aluminum alloy

Non-metallic materials

- Elastomers: Nitrile rubber, natural rubber, chloroprene rubber, butyl rubber, EPDM
- Silicon elastomer
- Fluorosilicone elastomer
- Polyurethane
- Polyvinyl

Information:

In case of doubt about the use of materials on the engine and add-on components / components in coolant circuit, consultation with the respective MTU specialist department must be held.

6.8 Fuel for gas engines

Gas engines must be operated exclusively with gases which have been specifically approved for the type of gas engine in use. The suitability for use of approved gas types must be checked regularly, but at least every six months, by means of a gas analysis in order to detect changes in the gas composition and changes to harmful components in the gas and to take appropriate action. In the entire application and operating range of the engine, the use of fuels is restricted to purely gaseous fuels. Liquid fuels are not permissible and not specified.

Components that may be used for gas engines are listed in the following tables. Generally valid limits for the main ingredients are specified in (→ Table 55) and (→ Table 56). Examples of typical natural gas compositions are shown in (→ Table 57) and (→ Table 58). The typical properties of fuel gases with a biogenic origin are shown in (→ Table 59). The listed components are relevant to gas engines. Components other than those listed below are not permitted for gas engines. They provide a reference value for the most common gas compositions used today. Limit values for the individual components, unless they are explicitly restricted, are based on the general requirements of freedom from fluid elements, the exclusion of condensate and hydrocarbons and the global parameters of gas mixing (→ Table 60).

Main ingredients of natural gases

Name	Components	Unit	Value range
Natural gas	CO	% by vol.	<2
	CO_2	% by vol.	<10
	CH_4	% by vol.	80-100
	C_2H_6	% by vol.	<12
	C_3H_8	% by vol.	<9
	C_4H_{10}	% by vol.	<1
	N_2	% by vol.	< 20
	O_2	% by vol.	< 3

Table 55:

Main ingredients of fuel gases of biogenic origin, mainly from fermentation processes

Name	Components	Unit	Value range
Fuel gases of biogenic origin	CO	% by vol.	unnamed
	CO_2	% by vol.	15 - 50
	CH_4	% by vol.	40 - 85
	C_2H_6	% by vol.	unnamed
	C_3H_8	% by vol.	unnamed
	C_4H_{10}	% by vol.	unnamed
	N_2	% by vol.	remainder
	O_2	% by vol.	remainder

Table 56:

Examples for natural gases

Typical natural gas compositions, natural gas H (according to DVGW worksheet G260)

		Russia	North Sea I	North Sea II	Network gas
CO	% by vol.	0.0000	0.0000	0.0000	0.0000
CO_2	% by vol.	0.1000	0.0000	0.3000	1.4000

		Russia	North Sea I	North Sea II	Network gas
CH_4	% by vol.	98.3000	88.6000	83.0000	88.6000
C_2H_4	% by vol.	0.0000	0.0000	0.0000	0.0000
C_2H_6	% by vol.	0.5000	8.4000	11.6000	5.3000
C_3H_6	% by vol.	0.0000	0.0000	0.0000	0.0000
C_3H_8	% by vol.	0.2000	1.7000	3.1000	1.4000
C_4H_6	% by vol.	0.0000	0.0000	0.0000	0.0000
C_4H_8	% by vol.	0.0000	0.0000	0.0000	0.0000
C_4H_{10}	% by vol.	0.1000	0.7000	0.5000	0.6000
C_5H_{12}	% by vol.	0.0000	0.0000	0.0000	0.0000
C_XH_Y	% by vol.	0.0000	0.0000	0.0000	0.0000
N_2	% by vol.	0.8000	0.6000	1.5000	2.7000
O_2	% by vol.	0.0000	0.0000	0.0000	0.0000
H_2	% by vol.	0.0000	0.0000	0.0000	0.0000
H_2O	% by vol.	0.0000	0.0000	0.0000	0.0000
H_2S	% by vol.	0.0000	0.0000	0.0000	0.0000
SO_2	% by vol.	0.0000	0.0000	0.0000	0.0000
Ar	% by vol.	0.0000	0.0000	0.0000	0.0000
Σ	% by vol.	100.000	100.000	100.000	100.000
Ho	kWh/m^3_N	11.1	12.2	12.5	11.5
Hu	kWh/m^3_N	10.0	11.0	11.3	10.3
Density	kg/m^3_N	0.731	0.810	0.853	0.814
rel. density	– –	0.56	0.62	0.66	0.63
Ws,n	kWh/m^3_N	14.7	15.4	15.4	14.5
Methane number	Methane no. (±2)	89	72	68	78

Table 57:

Typical natural gas compositions, natural gas L (according to DVGW worksheet G260)

		Holland I	Holland II	Osthannover (East Hanover)
CO	% by vol.	0.0000	0.0000	0.0000
CO_2	% by vol.	1.0000	1.3000	0.7000
CH_4	% by vol.	81.3000	82.9000	79.5000
C_2H_4	% by vol.	0.0000	0.0000	0.0000
C_2H_6	% by vol.	2.8000	3.7000	1.1000
C_3H_6	% by vol.	0.0000	0.0000	0.0000
C_3H_8	% by vol.	0.4000	0.7000	0.1000
C_4H_6	% by vol.	0.0000	0.0000	0.0000

		Holland I	Holland II	Osthannover (East Hanover)
C_4H_8	% by vol.	0.0000	0.0000	0.0000
C_4H_{10}	% by vol.	0.3000	0.3000	0.0000
C_5H_{12}	% by vol.	0.0000	0.0000	0.0000
C_XH_Y	% by vol.	0.0000	0.0000	0.0000
N_2	% by vol.	14.2000	11.1000	18.6000
O_2	% by vol.	0.0000	0.0000	0.0000
H_2	% by vol.	0.0000	0.0000	0.0000
H_2O	% by vol.	0.0000	0.0000	0.0000
H_2S	% by vol.	0.0000	0.0000	0.0000
SO_2	% by vol.	0.0000	0.0000	0.0000
Ar	% by vol.	0.0000	0.0000	0.0000
Σ	% by vol.	100.000	100.000	100.000
Ho	kWh/m^3_N	9.76	10.20	9.04
Hu	kWh/m^3_N	8.81	9.21	8.15
Density	kg/m^3_N	0.836	0.832	0.835
rel. density	– –	0.64	0.64	0.64
Ws,n	kWh/m^3_N	12.2	12.7	11.3
Methane number	Methane no. (±2)	90	86	101

Table 58:

Typical characteristics of fuel gases of biogenic origin from fermentation processes (according to DVGW worksheet G262)

		Biogas plants	Reference biogas plant in Northern Germany	Sewage gas plant	Landfill gas plant
CO	% by vol.	0	0	0	0
CO_2	% by vol.	15 - 50 (50*)	45*	20 - 35 (35*)	20 - 40 (40*)
CH_4	% by vol.	50 - 85 (50*)	52*	65 - 70 (65*)	65 - 70 (40*)
C_2H_4	% by vol.	0	0	0	0
C_2H_6	% by vol.	0	0	0	0
C_3H_6	% by vol.	0	0	0	0
C_3H_8	% by vol.	0	0	0	0
C_4H_6	% by vol.	0	0	0	0
C_4H_8	% by vol.	0	0	0	0
C_4H_{10}	% by vol.	0	0	0	0
C_5H_{12}	% by vol.	0	0	0	0
C_XH_Y	% by vol.	0	0	0	0
N_2	% by vol.	5 - 10 (0*)	2.4*	5 - 10 (0*)	10 - 20 (20*)

		Biogas plants	Reference biogas plant in Northern Germany	Sewage gas plant	Landfill gas plant
O_2	% by vol.	0 - 2,5 (0*)	0.6*	0 - 0.6 (0*)	0 - 2.7 (0*)
H_2	% by vol.	0	0	0	0
H_2O	% by vol.	*, **	*	*	*
H_2S	% by vol.	≤0.66 (0*)	≤0.005*	≤0.66 (0*)	≤0.66 (0*)
SO_2	% by vol.	0	0	0	0
Ar	% by vol.	0	0	0	0
Σ	% by vol.	100.000	100.000	100.000	100.000
The values marked with an asterisk * are used for calculating the following gas properties.					
Ho	kWh/m^3_N	5.53	5.75	7.19	4.42
Hu	kWh/m^3_N	4.98	5.18	6.48	3.99
Density	kg/m^3_N	1.347	1.301	1.158	1.323
rel. density	– –	1.042	1.006	0.896	1.027
Ws,n n = 0 °C, 101.32 kPa	kWh/m^3_N	5.42	5.73	7.6	4.37
Methane number	Methane no. (±2)	>140	146	133.8	>150

Table 59:

** = steam saturation corresponding to gas temperature

Requirements for gaseous fuel

Requirements and site conditions for natural gas fuel and the corresponding fuel supply

Designation	Unit	Limit value	Comment
Type of gas		Natural gas	Applies to natural gas H and L, other gases are currently not approved
Minimum methane number MZ min.	–	≥70	Depending on the model type, power and fuel consumption adaptations may be necessary. Operating Instructions (Techn. data) must be observed Consultation with manufacturer and gas analysis required in case of lower values.
Nominal methane number	– – – – – –	70 80 80 80 80 80	Engine type/model type Series 4000L62 Series 4000L62 epsilon reduced Series 4000L63 Series 4000L32 Series 4000L33 Series 4000L64
Methane number change	-/min	5	linear constant change with a frequency of maximum 1/h

Designation	Unit	Limit value	Comment
Calorific power Hu	kWh/m^3_N	8.0< Hu <11.0	Consultation with manufacturer required in case of lower and higher values.
Calorific value deviation from the setting value	%	± 5	Consultation with manufacturer required for higher values
Permissible change speed of calorific value in relation to setting value	%/min.	1.0	linear constant change necessary with a frequency of maximum 1/h
Density of gas	kg/m^3_N	0.73-0.84	The density of the gas can fluctuate in accordance with the composition; it is constant for a certain type of gas. When using gas from different gas supply areas, the density may vary. When changing the gas supplier, a gas analysis is necessary; an adaptation of the mixture control may be necessary.
Setting value for gas pressure, gas control valve inlet	mbar	80-200	Observe the specifications for the gas train corresponding to the project
Gas pressure deviation from the setting value	%	± 5	
Permissible change speed of gas pressure	mbar/min.	1	Constant change required
Gas temperature, natural gas from public gas supply network	°C	5< T <45	If there is a danger of undershooting the dew point, the gas temperature must be increased. In case of deviating temperatures, there is a danger of thermal aging of NBR materials (gaskets, diaphragms) and impairment of the elasticity behavior.
Natural gas from LNG evaporator plants	°C	15< T <45	On plants with LNG operation, the permissible temperature range must be coordinated project-specifically. The gas evaporation system design must be analyzed on the part of MTU for this purpose.
Gas temperature deviation from the setting value	°C	± 9	
Permissible change speed of gas temperature	K/min.	0.3	

Designation	Unit	Limit value	Comment
Relative gas humidity in the gas in the permissible temperature and pressure range, however maximum	% g/kg	< 80 20	No water vapor condensation in pressure and temperature range. No condensation permitted in lines and containers carrying fuel gas and fuel gas-air mixtures. At higher values or if there is a danger of condensation in the operating range of pressure and temperature, gas drying must be provided.
Oil vapors (HC with carbon number >5)	mg/m^3_N	< 0.4	No condensation in lines carrying fuel gas and fuel gas-air mixture, nor formation of condensable oil mists
HC solvent vapors	mg/m^3_N	0	Consultation with manufacturer and analysis necessary
Organically fixed silicium (e.g. hydrosilicons, siloxanes, silicons)	mg/m^3_N	< 1.0	Consultation with manufacturer and analysis necessary
Inorganically fixed silicium	$mg/m^3_N CH_4$	< 5	With Si >5 mg/m^3_N based on 100% CH_4 gaseous fuel content, wear products must be taken into consideration during the oil analysis.
Dust 3- 10 µm	mg/m^3N	5	Dust must be removed so that the trouble-free operation of gas devices and gas technical equipment, conforming to standards or other constructions, is guaranteed.
Dust<3 µm	mg/m^3N	technically free	dust <3 µm must be assessed by a technical analysis, corresponding special filters may need to be used.
Total sulfur	mg/m^3N	30	DVGW worksheet G260
Mercaptan sulfur	mg/m^3N	6	DVGW worksheet G260
Hydrogen sulfide H_2S	mg/m^3N	5	DVGW worksheet G260
Chlorine	mg/m^3N	10*	With higher values, consultation with manufacturer and analysis are necessary
Fluorine	mg/m^3N	5*	With higher values, consultation with manufacturer and analysis are necessary
Chlorine + fluorine	mg/m^3N	10*	With higher values, consultation with manufacturer and analysis are necessary
NH_3	ppm	70*	With higher values, consultation with manufacturer and analysis are necessary

Table 60:

* = For engines with exhaust aftertreatment and/or exhaust gas heat recovery, lower limit values may apply.

The limit values are based on a calorific value of 10 kWh/m^3_N. This corresponds to a reference to fuels with 100% by vol. methane or, if there are other combustible elements in the fuel, an equal energy equivalent and thus an equal input of pollutants.

Example:

Russian natural gas with a calorific value of 10 kWh/m^3_N (→ Table 57) is used. The permissible value for total sulfur in the gas thus corresponds exactly to the limit value specified in (→ Table 60).

When using gas from Osthannover, for example, with Hu = 8.15 kWh/m^3_N (→ Table 58), the permissible max. value of total sulfur is calculated thus:

permissible total sulfur content = 30 mg/m^3_N ∗ (8.15 kWh/m^3_N : 10.0 kWh/m^3_N) = 24.5 mg/m^3_N

No warranty is given in the event of impairment and / or damage (corrosion, contamination etc.) resulting from gases or materials the presence of which was unknown and not agreed upon on conclusion of contract.

Requirements and site conditions for fuel from biogenic gases from fermentation processes and the corresponding fuel supply

Designation	Unit	Limit value	Comment
Type of gas		Biogenic gases from fermentation processes	
Methane number	–	≥115	Below this limit there is a danger of combustion knock; gas analysis and consultation with manufacturer are required
Calorific power Hu	kWh/m^3N	4.5< Hu < 8.0	Consultation with manufacturer required in case of lower and higher values.
Calorific value deviation from the setting value	%	±20	Consultation with manufacturer required for higher values
Maximum change speed of calorific value in relation to setting value	%/min.	1.0	For starting procedures, changes to the calorific power <10%/min. with a frequency of 1/h are permissible.
Density of gas	kg/m^3_N	0.93 - 1.40	The gas density can fluctuate according to the composition. If there are changes to the main substrate and/or significant changes in the mixing ratio of the substrates, a gas analysis or, if necessary, an adaptation of the mixture control is necessary.
Setting value for gas pressure before gas control valve	mbar	30 - 60	Project-specific features must be noted when designing the gas train.
Gas pressure fluctuation in relation to setting value	%	±10	This applies to the gas inlet at the gas control valve on the engine side
Permissible change speed of calorific value	mbar/min.	1	This applies to the gas inlet at the gas control valve on the engine side

Designation	Unit	Limit value	Comment
Gas temperature at the gas inlet on the engine-side gas control valve	°C	5<t<45	Phase transitions in the fuel gas-air mixture during engine operation are not permissible. In the case of undershooting the dew point, the gas temperature must be increased. In case of deviating temperatures, there is a danger of thermal aging of NBR materials (gaskets, diaphragms) and impairment of the elasticity behavior.
Gas temperature fluctuation in relation to setting value	°C	±15	This applies to the gas inlet at the gas control valve on the engine side
Permissible change speed of gas temperature	K/min.	0.3	This applies to the gas inlet at the gas control valve on the engine side
Relative gas humidity in the gas in the permissible temperature and pressure range, however maximum	% g/kg	< 80 28	No water vapor condensation in the temperature and pressure range. No condensation permitted in lines and containers carrying fuel gas and fuel gas-air mixtures. At higher values or if there is a danger of condensation in the operating range of pressure and temperature, gas drying must be provided.
Oil vapors (HC with carbon number >5)	mg/m^3_N	< 0.4	No condensation in lines carrying fuel gas and fuel gas-air mixture, nor formation of condensable oil mists.
HC solvent vapors	mg/m^3_N	0	
Organically fixed silicium (e.g. hydrosilicons, siloxanes, silicons)	mg/m^3_N	< 4*	With Si >5 mg/m^3_Nbased on 100% CH_4, gaseous fuel content, wear products must be taken into consideration during the oil analysis.
Inorganically fixed silicium	mg/m^3_N	< 2*	With Si >5 mg/m^3_Nbased on 100% CH_4, gaseous fuel content, wear products must be taken into consideration during the oil analysis.
Dust 3- 10 µm	mg/m3<subscript />N	5	Dust must be removed so that the trouble-free operation of gas devices and gas technical equipment, conforming to standards or other constructions, is guaranteed.
Dust<3 µm	mg/m3<subscript />N	technically free	dust <3 µm must be assessed by a technical analysis, corresponding special filters may need to be used.
Silicium of organic (e.g. silicons) and inorganic compounds (e.g. hydrosilicons, siloxanes)	mg/m^3N	6*	
Total sulfur	mg/m^3N	800*	

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Designation	Unit	Limit value	Comment
Mercaptan sulfur	mg/m^3<sub-script />N	4*	
Hydrogen sulfide H_2S	mg/m^{3}N	850*	
Total of all chlorine and fluorine compounds	mg/m^{3}N	≤ 40*	
Chlorine	mg/m^{3}N	≤ 40*	With higher values, consultation with manufacturer and analysis are necessary
Fluorine		≤ 20*	With higher values, consultation with manufacturer and analysis are necessary
NH_3	ppm	70*	With higher values, consultation with manufacturer and analysis are necessary

Table 61:

* = For engines with exhaust aftertreatment and/or exhaust gas heat recovery, lower limit values may apply.

The limit values are based on a calorific value of 10 kWh/m^3 $_N$. This corresponds to a reference to fuels with 100% by vol. methane or, if there are other combustible elements in the fuel, an equal energy equivalent and thus an equal input of pollutants.

No warranty is given in respect of impairment and / or damage (corrosion, contamination etc.) resulting from gases or materials the presence of which was unknown and agreed upon on conclusion of contract.

7 NOx Reducing Agent AUS 32 for SCR Exhaust Gas Aftertreatment Systems

7.1 General information

SCR (Selective Catalytic Reduction) catalysts can be used for NO_x emission reduction. The reducing agent (urea solution with an urea concentration of 32.5%) in such catalysts reduces the nitrogen oxide emissions.

To ensure efficient operation of the exhaust gas after-treatment system, compliance of the reducing agent with the quality requirements stipulated in DIN 70070 / ISO 222 41-1 is mandatory.

In Europe, this reducing agent is often offered under the brand name “AdBlue”.

The test methods to determine the quality and characteristics of the reducing agent are specified in the standards DIN 70071 / ISO 222 41-2. The following table (→ Table 62) shows the quality characteristics of the reducing agent together with the associated test methods (extract from ISO 222 41-1).

SCR systems from MTU are usually designed for a concentration of 32.5% urea. The use of NOx reducing agent with other urea concentrations (AUS 40, AUS 48) requires a different design of the dosing systems. Systems with the corresponding design must be run with the appropriately adapted concentration.
The purity requirements of the reducing agent then comply with the standards for AUS 32

The use of antifreeze additives for AUS 32, or winter urea, is generally not approved.

Quality features and test procedures for the reducing agent

	Unit	Test method ISO	Limit values
Urea content	by weight %	22241–2 Annex B	31.8 - 33.2
Spec. grav. at 20 °C	kg/m^3	3675 12185	1087.0 - 1092.0
Refractive index at 20 °C		22241–2 Annex C	1.3817 - 1.3840
Alkalinity as NH_3	by weight %	22241–2 Annex D	Max. 0.2
Biuret content	by weight %	22241–2 Annex E	Max. 0.3
Aldehyde content	mg/kg	22241–2 Annex F	max. 5
Non-soluble constituents	mg/kg	22241–2 Annex G	Max. 20
Phosphate content as PO_4	mg/kg	22241–2 Annex B	Max. 0.5
Metal contents		22241–2 Annex I	
Calcium	mg/kg		Max. 0.5
Iron	mg/kg		Max. 0.5

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	Unit	Test method ISO	Limit values
Copper	mg/kg		Max. 0.2
Zinc	mg/kg		Max. 0.2
Chrome	mg/kg		Max. 0.2
Nickel	mg/kg		Max. 0.2
Aluminum	mg/kg		Max. 0.5
Magnesium	mg/kg		Max. 0.5
Sodium	mg/kg		Max. 0.5
Potassium	mg/kg		Max. 0.5
Identity			Identical with the reference sample

Table 62:

Storage of reducing agent

For instructions on storage, packing and transport, refer to the ISO 222 41-3 standard. The instructions of the manufacturer must be observed.

The reducing agent crystallizes at -11 °C.

Avoid direct sunlight because it promotes the occurrence of microorganisms and the decomposition of the reducing agent.

8 Approved Engine Oils and Lubricating Greases

8.1 Engine Oils for Four-Cycle Engines

8.1.1 Series-based usability of engine oils in MTU oil category 1

Series	Oil category 1	Oil category 1	Remarks
	Single-grade oils SAE30/40	Multigrade oils	
S60	no	no	
099	yes	yes	
183	yes	yes	
396	yes	yes	
538	yes	yes	
595	yes	yes	not for fast commercial vessels
956	no	no	all application
1163-01 Marine	yes	yes	not for fast commercial vessels
1163-02 Marine	no	no	not for fast commercial vessels
1163-02 TB32 emergency power, genset	no	no	
1163-03 Marine	yes	yes	
1163-04 Marine	no	no	
2000 CR	yes	yes	
2000 M84 / M94	no	no	
2000 M72	yes	yes	
2000 Cx6 / Gx6 / Gx7 / Mx6 / Sx6	no	no	
2000 PLD	yes	yes	
4000-00	yes	yes	
4000-01	yes	yes	
4000-02	yes	yes	
4000-03 G/S/P/C/R	yes	yes	
4000-03 Gx3F / Gx3G / Gx3H	no	no	
4000 M23F - M63L	yes	yes	
4000-03 M53B / M73-M93L / N43 / N83	no	no	
4000-04 C	no	no	
4000-04 M	no	no	
4000-04 R	no	no	

Series	Oil category 1	Oil category 1	Remarks
4000-04 T	no	no	
8000	no	no	

Table 63:

yes = approval issued

no = no approval

8.1.2 Single-grade oils – Category 1, SAE grades 30 and 40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines"(→ Page 7)

MTU/MTU-Detroit Diesel single grade engine oils

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8–10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
MTU Asia	Fascination of Power DEO SAE 40 Diesel Engine Oil - Cat. 1	40	X			18l canister: 80808/P 200l barrel: 81717/D

Table 64:

Other single-grade engine oils

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8–10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Marine MS4011	40	X			
	Addinol Turbo Diesel MD305	30		X		
	Addinol Turbo Diesel MD405	40		X		
Aegean Oil SA	Vigor Super D	40	X			
Avia	Avia Special HDC	30, 40	X			
Castrol Ltd.	Castrol MLC	30, 40		X		
Cepsa Lubricantes	Cepsa Rodaje Y Proteccion	30	X			Increased corrosion protection
Cyclon Hellas	Cyclon D Prime	30, 40	X			
ENI S.p.A	Agip Cladium 120	30, 40				Not for Series 2000, 4000
Gulf Oil International	Gulf Superfleet	40	X			
Misr Petroleum Company	Misr Super DEO CG-4	40	X			
Motor Oil (Hellas)	EMO Turbo Champion Plus	30, 40	X			
OMV AG	OMV truck	30, 40	X			
Pertamina, Indonesia	Meditran SMX	40	X			
Petrobras Distribuidora S.A.	Marbrax CCD-310	30		X		
	Marbrax CCD-410	40		X		
PTT Public Comp.	PTT Navita MTU Type 1	40	X			
Repsol Lubricantes y Especialidades, S.A.	Repsol Serie 3	30, 40		X		
	Repsol Marino 3	30		X		
	Repsol Marino 3 SAE 40	40			X	
SRS Schmierstoff Vertrieb GmbH	SRS Rekord	30, 40		X		

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8–10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Shell International Petroleum Company	Shell Gadinia	30, 40		X		
	Shell Rimula R3	30, 40	X			
	Shell Rimula R3+	30, 40	X			
	Shell Sirius Monograde	30, 40	X			
	SK Lubricants	SD 5000	40	X		
Total	Fina Delta Super	30, 40		X		
	Total Caprano TD 30	30		X		
	Total Caprano TD 40	40		X		
	Total Rubia S	30, 40		X		
United Oil	XD 7000 Extra Duty-3U	30	X			
	XD 7000 Extra Duty-4U	40	X			

Table 65:

8.1.3 Multigrade oils - Category 1, SAE grades 10W-40 and 15W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines"(→ Page 7)

[1] = These multigrade oils can only be used if crankcase ventilation is routed to atmosphere.

[2] = Engine oils marked [2] are also permitted for the "Series 60"

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Super Star MX 1547	15W-40		X		
Advanced Lubrication Specialties	Translub 15W40 CI-4	15W-40		X		
BP plc	BP Vanellus Multi	15W-40	X			
Claas	Claas Agrimot SDM	15W-40	X			
ENI S.p.A	Agip Superdiesel Multigrade	15W-40	X			[2]
Exxon Mobil Corporation	Mobil Delvac MX	15W-40	X			[1] and oil change interval 500 operating hours
	Mobil Delvac MX Extra	10W-40		X		[1] and oil change interval 500 operating hours
	Mobil Delvac Super 1400A	15W-40	X			[1] and oil change interval 500 operating hours
	Essolube XT 5	15W-40	X			[1] and oil change interval 500 operating hours
Gulf Oil International	Gulf Superfleet	15W-40	X			
OMV AG	OMV Truck M plus	15W-40	X			
OOO "LLK-International"	Lukoil-Avantgarde Extra	15W-40	X			
	Lukoil-Avantgarde	15W-40	X			
	Teboil Power Plus	15W-40	X			
OPET Petrolcülük	Omega Turbo Power SHPD	15W-40		X		[1] and oil change interval 500 operating hours
Petróleos de Portugal, Petrogal S.A.	Galp Galaxia Super 15W-40	15W-40	X			
Singapore Petroleum Company Limited	SPC SDM 801	15W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Primalub	15W-40	X			
Sinopec	Great wall century supremacy	15W-40		X		[2]
SK Lubricants	SD 5000 Gold	15W-40	X			[2]
Total	Fina Kappa Turbo DI	15W-40	X			
	Total Caprano TD	15W-40	X			
Unil Opal	Intercooler 400	15W-40	X			
United Oil	XD 9000 Ultra Diesel-U	15W-40	X			

Table 66:

8.1.4 Series-based usability of engine oils in MTU oil category 2 and 2.1 (low SAPS)

Series	Oil category 2 Single-grade oils	Oil category 2 Multigrade oils	Oil category 2.1 (low SAPS) Multigrade oils	Remarks
S60	no	restricted[1)]	restricted[2)]	[1)] = only 15W-40 and min. API CH-4 [2)] = only 15W-40 and API CJ-4
099	yes	yes	yes	
183	yes	yes	yes	
396	yes	yes	yes	
538	yes	yes	yes	
595 with carbon scraper ring	yes	yes	yes	
595 without carbon scraper ring	yes	yes	yes	
956	yes	yes	yes	
956-01 Marine, Rail	yes	yes	no	
956-02 Marine, Rail	yes	yes	no	
956 TB31 nuclear power station, emergency power	Mobil Delvac 1630 Mobil Delvac 1640 Power Guard® SAE 40 Off Highway Heavy Duty	Shell Rimula R3X 15W-40	no	
956 TB32 nuclear power station, emergency power	Mobil Delvac 1640 Power Guard® SAE 40 Off Highway Heavy Duty	Shell Rimula R3X 15W-40	no	
956 TB33 nuclear power station, emergency power Ɛ = 9	Mobil Delvac 1640 Power Guard® SAE 40 Off Highway Heavy Duty Q8 T 750 SAE 30 (Kuwait Petroleum)	no	no	
956 TB33 nuclear power station, emergency power Ɛ = 12	Sirius X 30	Fascination of Power DEO SAE 15W-40 Diesel Engine Oil Cat. 2 Shell Rimula R3X 15W-40	no	
956 TB34 nuclear power station, emergency power	Sirius X 30	Fascination of Power DEO SAE 15W-40 Diesel Engine Oil Cat. 2 Shell Rimula R3X 15W-40	no	
1163-01 Marine	yes	yes	yes	
1163-02 Marine	yes	yes	yes	

Series	Oil category 2 Single-grade oils	Oil category 2 Multigrade oils	Oil category 2.1 (low SAPS) Multigrade oils	Remarks
1163-02 TB 32 emergency power, genset	Sirius X 30	Fascination of Power DEO SAE 15W-40 Diesel Engine Oil Cat. 2 Shell Rimula R3X 15W-40	no	
1163-03 Marine	yes	yes	no	
1163-04 Marine	yes	yes	yes	
2000 CR	yes	yes	yes	
2000 M84 / M94	yes	yes	yes	
2000 M72	yes[3)]	yes	yes	[3)] = except for Mobil Delvac 1630/1640 & Power Guard® SAE 40 Heavy Duty
2000 Cx6 / Gx6 / Gx7 / Mx6 / Sx6	yes	yes	yes	
2000 PLD	yes	yes	yes	
4000-00	yes	yes	yes	
4000-01	yes	yes	yes	
4000-02	yes	yes	yes	
4000-03 G/S/P/C/R	yes	yes	yes	
4000-03 Gx3F / Gx3G / Gx3H	yes	yes	yes	
4000 M23F - M63L	yes	yes	yes	
4000 M53 / M73-M93L / N43 / N83	yes	yes	yes	
4000-04 C	no	no	only Fleet Supreme EC 15W-40	
4000-04 M	yes	yes	yes	
4000-04 R	no	no	no	
4000-04 T	no	no	only Chevron Delo 400 LE 15W-40	
8000	restricted [4)]	no	no	[4)]= only named engine oils Reapproval only after engine test in Series 8000

Table 67:

yes = approval issued

no = no approval

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8.1.5 Single-grade oils - Category 2, SAE grades 30 and 40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines"(→ Page 7)

MTU single-grade engine oils

	Brand name	SAE Viscosity class	TBN			Comments / material number
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
MTU Friedrichshafen GmbH	Power Guard® DEO SAE 40	40	X			20l container: X00062816 210l container X00062817 IBC: X00064829
MTU America	Power Guard® SAE 40 Off-Highway Heavy Duty	40		X		5 gallons: 23532941 55 gallons: 23532942 Approved for Series 8000(→ Table 68) available through MTU America Not approved for Series 2000 M72
MTU Asia	Fascination of Power DEO SAE 40 Diesel Engine Oil - Cat. 2	40		X		18l container: 93636/P 200l container 94545/D) available through MTU Asia
MTU Detroit Diesel Australia	MTU Premium SAE 30	30	X			Increased corrosion protection
	MTU Premium SAE 40 - Off-Highway	40	X			
MTU India Pvt Ltd.	Diesel Engine Oil DEO SAE 40	40		X		20l container: 73333/P 205l container: 75151/D Sale of Indian oil only intended in Indian market.

Table 68:

Note:

For Series 8000 engines, the approved SAE-40 engine oils may only be used in combination with preheating and oil priming (T_{oil}> 30 °C).

Other single-grade engine oils

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol	Addinol Turbo Diesel MD 407	40	X			
Adnoc Distribution	ADNOC Voyager Plus 40 CF/SL	40	X			
Atak Madeni Yag Lubricants	Protector MX 30	30			X	
	Protector MX 40	40			X	
BayWa AG	Tectrol HD 30	30		X		
	Tectrol HD 40	40		X		
Belgin Madeni Yaglar	Lubex Marine M	30		X		
	Lubex Marine M	40		X		
	Lubex Marine LTM-30	30		X		
	Lubex Marine LTM-40	40		X		
Castrol Ltd.	Castrol HLX	30, 40		X		Approved for fast commercial vessels up to 1500 h
Cepsa Lubricants	Cepsa Petrel HDL 40	40			X	
Chevron Lubricants	Texaco Ursa Super TD	30, 40		X		
	Texaco Ursa Premium TDX	40		X		
	Caltex Delo Gold [ISOSYN]	30, 40		X		
	Chevron Delo 400	30, 40		X		
	Dolo Gold	40		X		
Chevron – Lyteca –	Texaco Ursa Premium TDX	40		X		
Cyclon Hellas	Cyclon D Super	40		X		
Delek	Delkol Super Diesel	40		X		
	Delkol Super Diesel MT Mono	40	X			
ENI S.p.A.	Agip Sigma GDF	40		X		
Exxon Mobil Corporation	Mobil Delvac 1630	30		X		Not approved for Series 2000 M72
	Mobil Delvac 1640	40		X		Not approved for Series 2000 M72
Fuchs Europe Schmierstoffe GmbH	Titan Universal HD	30, 40	X			
	Titan Universal HD 30 MTU	30	X			Increased corrosion protection
Gulf Oil International	Gulf Superfleet Plus	40	X			
Gulf Western Oil, Australia	Turboil	40			X	
GS Caltex Corporation	Kixx D1 40	40	X			
Hyrax Oil Sdn Bhd	Hyrax Top Deo	40	X			

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Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Koçak Petrol Ürünleri San	Speedol Ultra HDX 30 TBN 12	30		X		
	Speedol Ultra HDX 40 TBN 12	40		X		
Koçak Petrol Ürünleri	Speedol Ultra HDX	30,40	X			
Kuwait Petroleum	Q8 T 750	30, 40	X			
Motor Oil, Hellas	EMO SHPD Plus	30, 40		X		
OMV Petrol Ofisi A.S.	PO Turbosarj Extra 30 A	30			X	
	PO Turbosarj Extra 40 A	40			X	
	PO Turbosarj Extra 30 L	30			X	
	PO Turbosarj Extra 40 L	40			X	
OOO Lukoil International	Lukoil Avantgarde M 40	40	X			
Oryx Energies	Supreme RR	40			X	
Panolin AG	Panolin Extra Diesel	40	X			
Paz Lubricants & Chemicals	Pazl Marine S 40	40	X			
Petrobras Distribuidora S.A.	Marbrax CCD-310-AP	30		X		
	Marbrax CCD-410-AP	40		X		
Petroleos de Potugal, Petrogal S.A.	Galp Galaxia 40	40		X		
PTT Public Comp.	PTT Navita MTU Type 2	40		X		
	Navita Plus, SAE 40	40		X		
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Serie 3 MT	40			X	
Shell International Petroleum Company	Shell Sirius X	30			X	
	Shell Sirius X	40			X	
Singapore Petroleum Company Limited	SPC SDM 40	40	X			
	SDM 900	30, 40	X			
	SPC SDM 900, SAE30	30	X			
	SPC SDM 900, SAE40	40	X			
Sonol, Israel	Sonol 2340	40		X		
Sonol	Seamaster 40	40	X			
SRS Schmierstoff Vertriebs GmbH	SRS Rekord plus 30	30		X		
	SRS Rekord plus 40	40		X		
	SRS Antikorrol M plus	30		X		Increased corrosion protection
Staroil Petrolcülük A.Ş	Triton STX 3016	30			X	
	Triton STX 4016	40			X	
Statoil Lubricants	PowerWay 30	30		X		
	PowerWay 40	40		X		

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Total	Total Caprano MT 30	30			X	
	Total Caprano MT 40	40			X	
	Total Disola MT 30	30	X			
	Total Disola MT 40	40	X			
	Total Rubia MT 30	30			X	
	Total Rubia MT 40	40			X	
ZAO Zavod imeni Shaumyana	M-14D2CE	40			X	

Table 69:

8.1.6 Multigrade oils - Category 2 of SAE grades 10W-40, 15W-40 and 20W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

[2] Engine oils marked [2] are also approved for "Series 60"

MTU multigrade engine oils

Manufacturer	Brand name	SAE Viscosity class	TBN 8 – 10 mgKOH/g	TBN 10 – 12 mgKOH/g	TBN >12 mgKOH/g	Remarks
MTU Friedrichshafen GmbH	Power Guard® DEO SAE 15W-40	15W-40		X		20l container: X00062818[2] 210l container: X00062819[2] IBC: X00064836[2]
MTU Asia	Fascination of Power DEO SAE 15W-40 Diesel Engine Oil - Cat. 2	15W-40	X			18l container: 91818/P[2] 200l container 92727/D[2] available through MTU Asia
	Fascination of Power DEO SAE 10W-40 Diesel Engine Oil - Cat. 2	10W-40	X			18l container: 82626/P[2] 200l container 83535/D[2] available through MTU Asia
	Diesel Engine Oil - DEO 15W-40	15W-40		X		20l container: 64242/P[2] 200l container: [2] available through MTU Indonesia
MTU Asia China	Diesel Engine Oil - DEO SAE 15W-40	15W-40		X		available through MTU Suzhou [2]
	Diesel Engine Oil - DEO SAE 10W-40	10W-40		X		available through MTU Suzhou
MTU Detroit Diesel Australia	MTU Premium Plus 15W-40	15W-40		X		[2]
MTU India Pvt. Ltd.	Diesel Engine Oil - DEO 15W-40	15W-40		X		20l container: 63333/P[2] Sale only intended in Indian market

Table 70:

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Other multigrade oils

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Adnoc Distribution	Adnoc Voyager Plus	15W-40		X		2)
Aegean Oil S.A.	Vigor Turbo SD 15W-40	15W-40	X			2)
Addinol Lube Oil	Addinol Super Longlife MD1047	10W-40		X		2)
	Addinol Diesel Longlife MD1548	15W-40		X		2)
Anomina Petroli Italiana	IP Tarus	15W-40	X			
	IP Tarus Turbo	15W-40	X			
	IP Tarus Turbo Plus	15W-40	X			2)
API	D Multi Diesel Turbo	15W-40		X		2)
Arabi Enertech KSC	Burgan Ultra Diesel CH-4	15W-40		X		2)
Aral AG	Aral Turboral	10W-40		X		
Atak Madeni Yag Lubricants	Alpet Turbot Fleetmax 1540	15W-40		X		2)
BayWa AG	Tectrol Super Truck 1540	15W-40		X		2)
	Tectrol Super Truck Plus 1540	15W-40	X			2)
	Tectrol Turbo 4000 A	10W-40		X		
Belgin Madeni Yaglar	Lubex Marine M	15W-40		X		
Bharat Petroleum	MAK MB SHPD 15W-40	15W-40		X		
Bölünmez Petrocülük A-S	MOIL Dizel 15W-40	15W-40		X		
BP p.l.c.	BP Vanellus C6 Global Plus	10W-40		X		
	BP Vanellus Multi-Fleet	15W-40	X			2)
	BP Multi Mine	15W-40	X			2)
	BP Vanellus Longdrain	15W-40		X		2)
	BP Vanellus Multi A	10W-40		X		2)
	BP Vanellus Agri	10W-40		X		2)
	BP Vanellus Multi A	15W-40	X			2)
	BP Vanellus Agri	15W-40	X			2)
	BP Vanellus Max Extra	15W-40			X	2)
Castrol Ltd.	Castrol Vecton 15W-40 DH-1	15W-40			X	2)
Cepsa	Cepsa Euromax SHPD	15W-40		X		2)

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Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Chevron Lubricants	Caltex Delo SHP Multigrade	15W-40		X		
	Caltex Delo Gold Multigrade	15W-40	X			
	Caltex Delo Gold [ISOSYN] Multigrade	15W-40		X		2)
	Caltex Delo Gold Ultra	15W-40		X		
	Caltex Delo 400 Multigrade	15W-40			X	
	Chevron Delo 400 Multigrade	15W-40			X	2)
	Chevron Delo Gold Multigrade	15W-40	X			
	Chevron Ursa Premium TDX Plus	15W-40		X		2)
	Chevron Ursa Super Plus	15W-40		X		2)
	Delo Gold Multigrade	15W-40	X			
	OEC SAE 15W-40	15W-40		X		
	Texaco Ursa Super Plus	15W-40		X		2)
	Texaco Ursa Super TD	15W-40		X		2)
	Texaco Ursa Super TDS	10W-40		X		2)
	Texaco Ursa Premium TD	10W-40	X			
	Texaco Ursa Premium TD	15W-40		X		
	Texaco Ursa Premium TDX	15W-40		X		2)
	Texaco Ursa Premium TDX Plus	15W-40		X		2)
	Texaco Ursa Ultra MG	15W-40		X		2)
	Ursa Premium TD 10W-40	10W-40		X		
	Ursa Premium TD	15W-40	X			2)
	Ursa Premium TDX	15W-40	X			
Chinese Petroleum Company	CPC Superfleet CG-4 Motor Oil	15W-40	X			
Cubalub	Cubalub Extra Diesel MX	15W-40			X	2)
	Cubalub Extra Diesel	15W-40	X			
Cyclon Hellas	Cyclon D Super	15W-40	X			2)
Delek	Delkol Super Diesel	15W-40	X			
EKO	Eko Forza Extra	15W-40	X			
Engen Petroleum Ltd.	Dieselube 700 Super	15W-40		X		2)
eni S.p.A.	Agip Blitum T	15W-40	X			
	eni i-Sigma super fleet	15W-40		X		
Exol Lubricants Ltd.	Taurus Extreme M	15W-40	X			2)
	Taurus Extreme HST	15W-40		X		2)

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Exxon Mobil Corporation	Mobilgard 1 SHC	20W-40			X	Approved for fast commercial vessels up to 1500 h
	Mobil Delvac Super 1400 E	15W-40	X			2)
	Mobil Delvac Super 1400	15W-40	X			2)
	Mobil Delvac XHP	15W-40	X			
Fuchs Europe Schmierstoffe GmbH	Fuchs Titan Truck Plus	15W-40		X		2)
	Titan Unimax Ultra MC	10W-40		X		
	Titan Formel Plus	15W-40		X		
	Fuchs Titan Truck	15W-40		X		2)
	Titan Unimax Plus MC	10W-40		X		
	Fuchs Titan Universal HD	15W-40	X			
Gazpromneft Lubricants Ltd.	G-Profi MSI 10W-40	10W-40		X		
	G-Profi MSI 15W-40	15W-40		X		
	G-Profi MSH 15W-40	15W-40	X			
	G-Profi MSI Plus	15W-40		X		2)
	Gazpromneft Diesel Premium	15W-40	X			
German Mirror Lubricants and Greases Co. FZE	Mirr Turbo Plus Diesel Engine Oil API CI-4 SAE 10W-40	10W-40		X		
	Mirr Turbo Plus Diesel Engine Oil API CI-4 SAE 15W-40	15W-40	X			
	Mirr Turbo Diesel Engine Oil API CI-4 SAE 15W-40	15W-40	X			
GS Caltex India Private Limited	Kixx Dynamic Gold	15W-40		X		2)
Gulf Oil International	Gulf Super Duty VLE	15W-40	X			
	Gulf Superfleet LE	10W-40		X		
	Gulf Superfleet LE	15W-40	X			2)
	Gulf Superfleet Supreme	10W-40		X		
	Gulf Superfleet Supreme	15W-40		X		2)
	Gulf Superfleet Plus	15W-40	X			
Gulf Western Oil, Australia	Gulf Western TOP DOG XDO	10W-40	X			2)
Hessol Lubrication GmbH	Hessol Turbo Diesel	15W-40		X		2)
Hitachi Construction Machinery CO., Ltd.	Hitachi Premium Orange	15-W40	X			
Huiles Berliet S.A.	RTO Maxima RD	15W-40	X			2)
	RTO Maxima RLD	15W-40		X		2)

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Hyrax Oil Sdn Bhd	Hyrax Admiral 15W-40	15W-40	X			2)
Igol, France	Protruck 100X	15W-40	X			2)
Kuwait National Lube Oil MfgCo (KNLOC)	Burgan Ultra Diesel CH-4	15W-40		X		2)
Kuwait Petroleum	Q8 T 720	10W-40	X			2)
	Q8 T 750	15W-40	X			2)
	Q8 T 800	10W-40	X			2)
Kocak Petrol Ürünleri San	Speedol SHPD Tirot 15W-40	15W-40		X		
Liqui Moly	Liqui Moly Touring High Tech SHPD	15W-40	X			
LLK Finland Oy	Teboil Power Plus	15W-40	X			
	Teboil Super HPD	10W-40		X		
	Teboil Super HPD	15W-40		X		
Lotos Oil	Turdus Powertec CI-4 15W-40	15W-40		X		2)
Lubrisa	Gulf Superfleet Supreme	15W-40		X		2)
Mega Lube Marketers cc.	Megalube Diesel Engine Oil	15W-40		X		
Meguin GmbH	megol Motorenoel SHPD	15W-40	X			
MOL-LUB Kft..	MOLDynamic MK9	15W-40		X		
	MOL Mk-9	15W-40		X		
	Mol Dynamic Super Diesel	15W-40	X			
	Mol Dynamic Transit	10W-40		X		2)
Morris Lubricants	Ring Free V.S. plus	15W-40	X			2)
Motor Oil, Hellas	EMO SHPD Plus	15W-40		X		
Orlen	Platinum Ultor	15W-40	X			2)
	Platinum Ultor Plus	15W-40			X	2)
OMV Refining & Marketing GmbH	OMV eco truck extra	10W-40		X		
	OMV truck LD	15W-40			X	2)
OMV Petrol Ofisi	PO Maximus Turbo Diesel Extra	15W-40		X		2)
OOO "LLK-International"	BELAZ CI-4	15W-40	X			
	Lukoil Avantgarde Extra	15W-40	X			
	Lukoil Avantgarde Ultra	15W-40		X		
	Teboil Super HPD	15W-40		X		2)
	Avantgarde Ultra	15W-40		X		2)
Panolin AG	Panolin Universal SFE	10W-40		X		
	Panolin Diesel Synth	10W-40		X		

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Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Pertamina	Meditran SMX	15W-40		X		2)
	Meditran SX Plus	15W-40		X		2)
Petrobras Distribuidora S.A.	Lubrax Nautica Diesel	15W-40		X		2)
Petro-Canada Lubricants	Duron	15W-40		X		2)
	Duron XL Synthetic Blend	15W-40		X		2)
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia LD star	15W-40		X		
Petrolimex Petrochemical Joint-Stock Company	PLC Diesel SHPD 15W-40	15W-40		X		2)
Petronas Lubricants International	Urania LD7	15W-40		X		
	Petronas Urania ID 7	10W-40	X			
	Petronas Urania Supremo CI-4	15W-40	X			2)
Petromin Corporation	Petromin Turbo Master XD	15W-40		X		
Phillips 66 Lubricants	Conoco Hydroclear Power D	15W-40			X	
Prista Oil AD	Prista SHPD	15W-40	X			2)
	Prista Turbo Diesel	15W-40	X			
PTT Public Limited	Navita Plus SAE 15W-40	15W-40	X			
Qatar Lubricants Company Ltd.	QALCO Topaz HMF	15W-40	X			
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Expert SHPD	10W-40		X		
	RAVENOL Mineralöl Turbo Plus SHPD	15W-40	X			2)
Raj Petro Specialities P Ltd.	Zoomol Rforce 3100 RF 1	15W-40	X			2)
Repsol Lubricantes y Especialidades, S.A.	Repsol Extra Vida MT	15W-40	X			
	Repsol Neptuno S-Turbomar	15W-40	X			
ROWE Mineralölwerk GmbH	ROWE Hightec Formula GT SAE 10W-40 HC	10W-40		X		2)
S.A.E.L.	Gulf Gulfleet Long Road	15W-40	X			

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Shell International Petroleum Company	Shell Rimula MV	15W-40	X			
	Shell Rimula R3 MV	15W-40	X			2)
	Shell Rimula R3 X	15W-40		X		
	Shell Rimula R4	15W-40		X		2)
	Shell Rimula R4 X	15W-40		X		2)
	Shell Rimula RT4	15W-40		X		2)
	Shell Rimula RT4 X	15W-40		X		2)
	Shell Rimula X	15W-40		X		
	Shell Rotella T2	15W-40		X		
	Shell Rotella T Multigrade	15W-40		X		2)
	Shell Sirius	15W-40		X		2)
Singapore Petroleum Company Limited	SPC SDM 900 SAE 15W40	15W-40		X		
SRS Schmierstoff Vertrieb GmbH	SRS Motorenöl O-236	15W-40	X			2) enhanced corrosion protection
	SRS Multi-Rekord top	15W-40		X		2)
	SRS Multi Rekord plus	15W-40	X			
	SRS Turbo Rekord	15W-40	X			2)
	SRS Turbo Diesel Plus	15W-40		X		2)
	SRS Cargolub TFX	10W-40		X		
Statoil Lubricants	MaxWay	10W-40		X		2)
	MaxWay 15-40	15W-40	X			2)
Tesla Technoproducts FZE	Denebola Saheli Ultra XS 1120	15W-40		X		2)

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Total	Antar Milantar PH	15W-40	X			2)
	Antar Milantar PX	15W-40	X			2)
	Elf Performance Trophy DX	15W-40	X			2)
	Fina Kappa Optima	15W-40		X		2)
	Fina Kappa Extra Plus	15W-40	X			2)
	Total Caprano Energy FE	15W-30		X		
	Total Caprano TDH	15W-40		X		2)
	Total Caprano TDI	15W-40		X		2)
	Total Disola SGS	15W-30		X		
	Total Disola W	15W-40		X		
	Total Genlub TDX	15W-40	X			
	Total Rubia TIR 7200 FE	15W-30		X		
	Total Rubia Works 1000	15W-40		X		2)
Unil Opal	Medos 700	15W-40	X			2)
Valvoline	All Fleet Extra SAE 15W-40	15W-40	X			2)
	All Fleet Plus	15W-40	X			2)
Wunsch Öle GmbH	Wunsch Rekord TLM-TU 10W-40	10W-40		X		

Table 71:

8.1.7 Multigrade oils – Category 2.1 (low SAPS oils)

For details and special features, see chapter "Lubricants for four-cycle engines"(→ Page 7)

[2] Engine oils marked [2] are also approved for "Series 60"

MTU multigrade oils category 2.1

Manufacturer	Brand name	SAE Viscosity class	TBN 8 – 10mgKOH/g	TBN 10 – 12 mgKOH/g	TBN >12 mgKOH/g	Remarks
MTU America	Power Guard® SAE 15W-40 Off-Highway Heavy Duty	15W-40	X			5 gallons: 800133 55 gallons: 800134 IBC: 800135 available through MTU America [2]

Table 72:

Further multigrade oils category 2.1

Manufacturer	Brand name	SAE Viscosity class	TBN 8 – 10mgKOH/g	TBN 10 – 12 mgKOH/g	TBN >12 mgKOH/g	Remarks
Bucher AG Langenthal	Motorex Focus CF	15W-40	X			[2]
Castrol Ltd.	Castrol CRB Mining 15W-40	15W-40	X			[2]
	Castrol CRB Turbo G4 15W-40	15W-40	X			[2]
	Castrol Hypuron	10W-30		X		
	Castrol Rivermax RX+ 15W-40	15W-40	X			[2]
Chevron Lubricants	Caltex Delo 400 LE	15W-40	X			[2]
	Chevron Delo 400 LE	15W-40	X			[2] also approved for Series 4000-04 T
	Texaco Ursa Ultra LE	15W-40	X			[2]
ExxonMobil Corporation	Mobil Delvac 1 ESP	5W-40		X		
	Mobil Fleet	15W-40	X			[2]
Fuchs Europe	Fuchs Titan Cargo	15W-40	X			[2]
Gulf Oil International	Gulf Supreme Duty XLE	15W-40	X			[2]
Kuwait Petroleum	Q8 T 760	10W-30	X			
Lotos Oil	Turdus Powertec 1100	15W-40	X			[2]

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Morris Lubricants	Ring Free Ultra Plus	15W-40	X			2)
OMV Refining & Marketing GmbH	OMV truck blue GS	10W-30	X			
	OMV truck blue GS	10W-40	X			
Panolin AG	Panolin Universal LA-X	15W-40	X			2)
Pennzoil Products	Pennzoil Long-Life Gold	15W-40		X		2)
Petro-Canada	Duron -E	15W-40	X			2)
Phillips 66 Lubricants	Fleet Supreme EC	15W-40	X			2) also approved for Series 4000-04 C
	Guardol ECT	15W-40	X			2)
	Kenndall Super-D XA	15W-40	X			2)
Repsol Lubricantes Y Especialidades, S.A.	Repsol Diesel Turbo THPD Mid Saps	15W-40	X			2)
Shell International Petroleum Company	Shell Rimula Super	15W-40		X		2)
	Shell Rimula RT4L	15W-40		X		2)
	Shell Rotella T	15W-40		X		2)
	Shell Rotella T3	15W-40		X		2)
	Shell Rotella T5	10W-30	X			
	Shell Rotella T5	10W-40	X			
	Shell Rimula R5LE	10W-30	X			
	Shell Rimula R5LE	10W-40	X			2)
	Shell Rotella T Triple Protection	15W-40		X		
SK energy	ZIC XQ 5000	15W-40	X			2)
SRS Schmierstoff Vertrieb GmbH	SRS Turbo Rekord plus	15W-40	X			2)
	SRS Turbo Rekord plus FE	10W-40	X			
Statoil Lubricants	MaxWay E9 15W-40	15W-40	X			2)
Total	Total Rubia TIR 7900	15W-40	X			
	Total Rubia Works 2000 FE 10W-30	10W-30	X			2)
Trinidad & Tobago National Petroleum Marketing Company Ltd. (NPMC)	Ultra Duty 15W-40 Engine Oil	15W-40	X			2)
Valvoline	Valvoline All Fleet Extra LE SAE 15W-40	15W-40	X			2)

Table 73:

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8.1.8 Series-based usability of engine oils in MTU oil category 3 and 3.1 (low SAPS)

Series	Oil category 3	Oil category 3.1 (low SAPS)	Remarks
	Multigrade oils	Multigrade oils	
S60	restricted[1)]	restricted[2)]	[1)] = only 15W-40 and min. API CH-4 [2)] = only 15W-40 and API CJ-4
099	yes	yes	
183	yes	yes	
396	yes	yes	
538	yes	yes	
595	yes	yes	
956	yes	yes	
956 TB31/ 32/ 33	no	no	
1163-01 Marine	yes	yes	
1163-02 Marine	yes	yes	
1163-02 TB32 Emergency power, genset	no	no	
1163-03 Marine	yes	yes	
1163-04 Marine	yes	yes	
2000 CR	yes	yes	
2000 M84 / M94	yes	yes	
2000 M72	yes	yes	
2000 Cx6 / Gx6 / Gx7 / Mx6 / Sx6	yes	yes	
2000 PLD	yes	yes	
4000-00	yes	yes	
4000-01	yes	yes	
4000-02	yes	yes	
4000-03 G/S/P/C/R	yes	yes	
4000-03 Gx3F / Gx3G / Gx3H	yes	yes	
4000 M23F - M63L	yes	yes	
4000-03 M53B / M73-M93L / N43S / N83	yes	yes	
4000-04 C	yes	yes	only 5W-40, 10W-40
4000-04 M	yes	yes	
4000-04 R	no	yes	only 5W-40, 10W-40
4000-04 T	yes	yes	only 5W-40, 10W-40
8000	restricted [5)]	restricted [6)]	[6)]= only named engine oils

Table 74:

yes = approval issued

no = no approval

8.1.9 Multigrade oils – Category 3, SAE grades 5W-30, 5W-40, and 10W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

MTU multigrade oils category 3

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
MTU Asia China	Diesel Engine Oil - DEO 5W-30	5W-30			X	available through MTU Suzhou

Table 75:

Further multigrade oils category 3

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Ultra Truck MD 0538	5W-30			X	
	Addinol Super Truck MD 1049	10W-40			X	
Aral AG	Aral Mega Turboral	10W-40			X	
	Aral Super Turboral	5W-30			X	
Avia Mineralöl AG	Avia Turbosynth HT-E	10W-40			X	
	Avia Turbosynth HT-U	5W-30			X	
BayWa AG	Tectrol Super Truck 530	5W-30			X	
	Tectrol Super Truck 1040	10W-40		X		
BP p.l.c.	BP Energol IC-MT 10W-40	10W-40			X	
	BP Vanellus Max	5W-30			X	
Bucher AG Langenthal	Motorex MC Power PLus	10W-40			X	
Castrol Ltd.	Castrol Enduron MT	10W-40			X	
	Castrol Enduron Plus	5W-30			X	
	Castrol Elixion HD	5W-30			X	
	Castrol Vectron Long Drain	10W-40			X	
	Castrol Vectron Long Drain E7 10W-40	10W-40			X	
	Castrol Vectron 5W-30 Arctic	5W-30			X	
	Castrol Vectron Fuel Saver 5W-30	5W-30			X	
Cepsa	Cepsa Eurotrans SHPD	5W-30			X	
	Cepsa Eurotrans SHPD	10W-40		X		

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Chevron Lubricants	Caltex Delo XLD Multigrade	10W-40			X	
	Chevron Delo XLD Multigrade	10W-40			X	
	Texaco Ursa HD	10W-40			X	
	Texaco Ursa Premium FE	5W-30			X	
	Texaco Ursa Super	10W-40		X		
	Texaco Ursa Super TDX	10W-40			X	
	Ursa TDX	10W-40			X	
ENI S.p.A.	Agip Sigma Trucksint TFE	5W-40			X	
	Agip Sigma Super TFE	10W-40			X	
Enoc	Enoc Vulcan 770 SLD	10W-40		X		
Exxon Mobil Corporation	Mobil Delvac XHP Extra	10W-40			X	
	Mobil Delvac XHP Ultra 5W-30	5W-30			X	
	Mobil Delvac 1 SHC 5W-40	5W-40			X	
Exol Lubricants Ltd.	Taurus Extreme M3	10W-40			X	
Fuchs Europe Schmierstoffe GmbH	Titan Cargo SL	5W-30			X	
	Titan Cargo MC	10W-40			X	
Gulf Oil International	Gulf Fleet Force synth.	5W-30			X	
	Gulf Superfleet ELD	10W-40			X	
	Gulf Superfleet XLD	10W-40			X	
Huiles Berliet S.A.	RTO Extensia RXD ECO	5W-30			X	
Iranol Oil Co.	Iranol D – 40000	10W-40		X		
Kuwait Petroleum	Q8 T 860	10W-40		X		
	Q8 T 905	10W-40	X			
LLK Finland Oy	Teboil Super XLD-2	5W-30			X	
Lotos Oil	Turdus Semisynthetic XHPDO	10W-40		X		
	Turdus Powertec 3000	10W-40			X	
Meguin	Megol Motorenöl Super LL Dimo Premium	10W-40			X	
MOL-LUB Kft	MOL Synt Diesel	10W-40		X		
	MOL Dynamic Synt Diesel E4	10W-40			X	
OMV Refining & Marketing GmbH	OMV super truck	5W-30			X	
	OMV super truck	10W-40			X	
Orlen Oil Sp.o.o.	Platinum Ultor Max	5W-30			X	
OOO LLK International	Lukoil Avantgarde Professional M5	10W-40			X	
Panolin	Panolin Diesel HTE	10W-40			X	

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Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia Extreme	5W-30		X		
	Galp Galaxia Ultra XHP	10W-40			X	
Petronas Lubricants International	Petronas Akros Synt Gold	10W-40			X	
	Arexons HD-Truck E7	10W-40			X	
	Urania Maximo	10W-40			X	
	Petronas Urania Optimo	10W-40			X	
	Urania 100 K	10W-40			X	
	Urania FE	5W-30			X	
	Petronas Urania Maximo	5W-30			X	
PHI OIL GmbH	Motordor Silver 10W40	10W-40			X	
Raj Petro Specialities P Ltd.	Zoomol Rforce 8200 RF1	10W-40			X	
Ravensberger Schmierstoff Vertrieb GmbH	RAVENOL Super Performance Truck	5W-30			X	
	RAVENOL Performance Truck	10W-40			X	
Repsol Lubricantes y Especialidades S.A.	Repsol Turbo UHPD	10W-40			X	
	Repsol Diesel Turbo VHPD	5W-30			X	
	Repsol Diesel Turbo UHPD Urban	10W-40			X	
ROWE Mineralölwerk GmbH	ROWE Hightec Formula GT SAE 10W-40 HC	10W-40			X	
Shell International Petroleum Company	Shell Normina Extra	10W-40			X	
	Shell Rimula R5 M	10W-40			X	
	Shell Rimula R6 M	10W-40			X	
	Shell Rimula R6 ME	5W-30			X	
	Shell Rimula R6 MS	10W-40			X	
SMV GmbH JB German Oil	JB German Oil Hightech Truck	10W-40			X	
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TFF	10W-40			X	
	SRS Cargolub TFL	5W-30			X	
	SRS Cargolub TFG	10W-40			X	
	SRS Cargolub TFG plus	10W-40			X	
Statoil Lubricants	MaxWay Ultra 5W-30	5W-30			X	
	MaxWay Ultra E4 10W-40	10W-40			X	
Total	Antar Maxolia	10W-40		X		
	Fina Kappa Syn FE	5W-30			X	
	Gulf Gulfleet Highway 10W-40	10W-40			X	
	Total Rubia TIR 8600	10W-40			X	
	Total Rubia TIR 9200 FE	5W-30			X	
Transnational Blenders B. V.	Engine Oil Super EHPD	10W-40			X	

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Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Unil Opal	LCM 800	10W-40			X	
Valvoline EMEA	All Fleet Superior	10W-40			X	
	Profleet	10W-40			X	
Yacco SAS	Yacco Transpro 45	10W-40			X	

Table 76:

8.1.10 Multigrade oils - Category 3.1 (low SAPS oils)

For details and special features, see chapter "Lubricants for four-cycle engines"(→ Page 7)

[2] Engine oils marked [2] are also approved for "Series 60"

Manufacturer	Brand name	SAE Viscosity class	TBN			Comments / material number
			8 – 10mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Extra Truck MD 1049 LE	10W-40	X			
Aral AG	Aral Mega Turboral LA	10W-40			X	
BayWa AG	Tectrol Super Truck Plus 1040	10W-40			X	
Bucher AG Langenthal	Motorex Focus QTM	10W-40	X			
	Motorex Nexus FE SAE 5W-30	5W-30	X			
BP p.l.c.	BP Vanellus Max Drain Eco	10W-40			X	
	BP Vanellus Max Eco 10W-40	10W-40			X	
BVG Vertriebsgesellschaft AG	Alpha Advanced Eco-Efficiency low SAPS	10W-40	X			
Castrol Ltd.	Castrol Vecton Long Drain10W-30 E6/E9	10W-30	X			
	Castrol Vecton Long Drain10W-40 E6/E9	10W-40	X			
	Castrol Vecton Fuel Saver 5W-30 E6/E9	5W-30	X			
Cepsa Comercial Petroleo, SA	Cepsa Eurotech LS 10W40 Plus	10W-40			X	
Chevron Lubricants	Caltex Delo XLE Multigrade	10W-40	X			
	Delo 400 LE Synthetic	5W-30	X			
	Delo 400 XLE Synthetic	5W-30	X			
	Texaco Ursa Premium TDX (E4)	10W-40			X	
	Texaco Ursa Ultra	10W-40	X			
	Texaco Ursa Ultra X	10W-30		X		
	Texaco Ursa Ultra X	10W-40	X			
	Ursa Ultra XLE	5W-30	X			
De Oliebron B.V.	Tor turbosynth LSP Plus 10W40	10W-40			X	
eni S.p.a.	eni i-Sigma top MS	10W-40	X			
Enoc International Sales L.L.C.	Vulkan green	10W-40	X			
Exxon Mobil	Mobil Delvac 1 LE	5W-30	X			
	Mobil Delvac XHP LE	10W-40			X	55 gallons: 800141
	Mobil Delvac XHP Ultra LE 5W-30	5W-30	X			
Fuchs	Titan Cargo Maxx	5W-30		X		
	Titan Cargo Maxx	10W-40	X			

Manufacturer	Brand name	SAE Viscosity class	TBN			Comments / material number
			8 – 10mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Gulf Oil International	Gulf Superfleet ULE	5W-30	X			
	Gulf Superfleet XLE	10W-40	X			
	Gulf Superfleet Synth XLE	10W-30		X		
	Gulf Superfleet Synth XLE	10W-40		X		
Helios Lubeoil	Helios Premium KMXX 10W-40	10W-40	X			
Huiles Berliet S.A.	RTO Extensia FP	10W-40	X			
Igol	Protruck 200 X	10W-40	X			
INA Maziva d.o.o.	INA Super 2009 5W-30	5W-30	X			
INA Rfinerija nafte Rjeka	INA Super 9000	10W-40			X	
JB German Oil GmbH & Co. KG	JB German Oil Truckstar	10W-40		X		
Kuwait Petroleum R&T	Q T 900	10W-40	X			
	Q8 905	10W-40	X			
	Q8 T 904	10W-40		X		
	Q8 T 905	10W-40	X			
	Q8 T 910	5W-30	X			
LLK finland Oy	Teboil Super XLD-2	5W-30			X	
Morris Lubricants	Ring Free Ultra	10W-40		X		
Oel-Brack AG	Midland maxtra	10W-40		X		
OMV Petrol Ofisi A.Ş	Maximus HD-E	5W-30	X			
OMV Refining & Marketing GmbH	OMV truck blue ET	5W-30	X			
	OMV truck blue ET	10W-40	X			
OOO LLK International	Lukoil Avantgarde Professional LS	10W-40			X	
Orlen Oil	Platinum Ultor Progress	10W-40		X		
Panolin	Panolin Diesel Synth EU-4	10W-40	X			
	Panolin Ecomot	5W-30		X		
Petro-Canada Lubricants Inc.	Duron-E UHP 5W30	5W-30	X			
Petróleos de Portugal	Galp Galaxia Ultra LS	10W-40	X			
Petronas Lubricants International	Duron UHP 10W-40	10W-40	X			
	Petronas Urania FE LS	5W-30			X	
	Petronas Urania Ecotech	10W-40			X	
PHI OIL GmbH	Motodor LSP Gold 5W30	5W-30			X	
Prista Oil Ad	Prista UHPD	10W-40	X			
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Turbo UHPD MID SAPS	10W-40	X			
	Repsol DieselTurbo VHPD Mid Saps	5W-30		X		
Rowe Mineralölwerk GmbH	Rowe Hightec Truckstar SAE 10W-40 HC-LA	10W-40		X		

Manufacturer	Brand name	SAE Viscosity class	TBN			Comments / material number
			8 – 10mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Shell International Petroleum Company	Shell Rimula R6 LM	10W-40	X			
	Shell Rimula R6 LME	5W-30	X			
SK energy	ZIC XQ 5000	10W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TLA	10W-40	X			
	SRS Cargolub TLS	5W-30			X	
	SRS Cargolub TLS plus	5W-30		X		
	SRS Turbo Diesel LA	10W-40	X			
	SRS Cargolub low-friction engine oil LA	10W-40		X		
Statoil Lubricants	MaxWay Ultra E6 10W-40	10W-40			X	
Total	Elf Performance Experty LSX	10W-40	X			
	Total Rubia TIR 8900	10W-40	X			
	Total Rubia Works 2500	10W-40	X			
Transnational Blenders B. V.	Engine Oil Synthetic UHPD E6	10W-30		X		
	Engine Oil Synthetic UHPD E6	10W-40		X		
	Motor oil SCR	10W-40	X			
Valvoline EMEA	Valvoline ProFleet LS	5W-30			X	
	Valvoline ProFleet LS	10W-40	X			
Wibo Schmierstoffe GmbH	Wibokraft Ultra AF 10W40	10W-40		X		
Yacco SAS	Yacco Transpo 65	10W-40			X	

Table 77:

8.2 Engine Oils for Gas Engines

8.2.1 Series-based usability of engine oils in SAE grade 40

For details and special features, see chapter on "Lubricants"(→ Page 7)

Manufacturer	Brand name	SAE Viscosity class	Model type approval			
			4000L61 / L62 / L63	4000 L32FB / L62 FB	4000 L32 / L33	4000 L64
Addinol	MG 40 Extra LA	40		yes		
	MG 40 Extra Plus	40		yes		
Castrol Ltd.	Castrol Duratec L	40	yes		yes[1)]	
Chevron	Texaco Geotex LA 40	40	yes		yes[1)]	
	HDAX 7200	40	yes		yes	yes
Exxon Mobil Corporation	Mobil Pegasus 705	40	yes		yes[1)]	
	Mobil Pegasus 805 55 gallons: 23538056	40	yes		yes[1)]	
	Mobil Pegasus 1005	40	yes		yes	yes
Fuchs Europe Schmierstoffe GmbH	Titan Ganymet Ultra	40		yes		
	Titan Ganymet LA	40	yes			
Shell International Petroleum Company	Shell Mysella S3 N 40	40	yes		yes[1)]	
	Shell Mysella S5 N 40	40	yes			
SRS Schmierstoff Vertrieb GmbH	SRS Mihagrun LA 40	40	yes		yes[1)]	
Total	Nateria MH 40	40	yes		yes[1)]	
	Nateria MJ 40	40		yes		
	Nateria MP 40	40	yes	yes	yes	yes
Pedro-Canada	Sentron CG 40	40		yes		
	Sentron LD 8000	40	yes		yes	yes

Table 78:

[1)] = The use of these engine oils shortens the service life!

8.3 Engine Oils for Two-Cycle Engines

8.3.1 Series-based usability for two-cycle engine oils

Series	Two-cycle engine oil API CF-2			Comments
	Single-grade oils SAE 40	Single-grade oils SAE 50	Multigrade oils 15W-40	
S 53	yes	restricted[1]	restricted[1]	[1]only short term at low temperatures [2]at coolant outlet temp. > 94 °C
S 71	yes	restricted[1]	restricted[2]	
S 92	yes	restricted[1]	restricted[2]	
S 149	yes[2]	yes	no	

Table 79:

8.3.2 Engine oils for two-cycle engines

If the engine oils listed here are not available, two-cycle engine oils may be used, provided they comply with the requirements listed in the table (Engine oil requirements for two-cycle engines (→ Page 20).

MTU two-cycle engine oil

Manufacturer & sales region	Product name	SAE grade & oil category	Comments / material number
MTU America America	Power Guard® Heavy-duty Diesel Engine Oil for Detroit Diesel 2-Cycle (4X1G) SAE 40	40, API CF-2	4X1 gallons: 23512701
	Power Guard® Heavy-duty Diesel Engine Oil for Detroit Diesel 2-Cycle SAE 40	40, API CF-2	5 gallons: 23512734 55 gallons: 23512702 IBC: 23512739

Table 80:

Further two-cycle engine oils

Manufacturer	Product name	SAE grade & oil category	Comments / material number
Bucher AG Langenthal	Motorex Extra SAE 40	40	
Chevron	Ursa Extra Duty SAE 40	40	
	Ursa Extra Duty SAE 50	50	
ExxonMobil	Exxon XD-3 Monogrades SAE 40	40	
	Mobile Delvac 1240	40	
	Mobile Delvac 1250	50	
Panolin	Extra Diesel DD SAE 40	40	
Shell International Petroleum Company	Shell Rotella DD+40	40	

Table 81:

8.4 Lubricating Greases

8.4.1 Lubricating greases for general applications

For details and special features, see chapter on "Lubricants"(→ Page 17)

Manufacturer	Brand name	Remarks
Aral AG	Mehrzweckfett Arallub HL2	
BP p.l.c.	Energrease LS2	
Castrol Ltd.	Spheerol AP2	
Chevron	Multifak EP2	
SRS Schmierstoff Vertrieb GmbH	SRS Wiolub LFK2	
Shell Deutschland GmbH	Shell Gadus S2 V220 2	
Total	Total Multis EP2	
Veedol International	Multipurpose	

Table 82:

9 Approved Coolants

9.1 Series- and application-based usability of coolant additives

All details are based on the coolant circuit on the engine side, no allowance is made for external add-on components.

In the case of an engine coolant circuit with no light metal elements but with add-on components containing light metal (e.g. external cooling system), the coolant approvals for cooling systems containing light metal shall apply. If you have any doubts about a coolant application, consult your contact person at MTU.

For details and special features, see chapter on "Coolants" (→ Page 23)

Any deviating special agreements between the customer and MTU-Friedrichshafen shall remain valid.

MTU four-cycle engines

X = application approval

– = no application approval

Series	Application	Cooling system containing light metals	Emulsions See chapter	Water-soluble corrosion inhibitors See chapter		Corrosion-inhibiting antifreezes See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
099	Marine	yes	–	X	–	X[1)]	–	–	–	[1)] not permitted at seawater temperature > 20 °C !
183	Marine	yes	–	X	–	X[2)]	–	–	–	[2)] not permitted at seawater temperature > 20 °C !
183	Rail		–	X	–	X	–	–	–	
396	Marine	yes	–	X	–	X[3)]	–	–	–	[3)] not permitted at seawater temperature > 20 °C !
396 TB	Marine	yes	–	X	–	X	–	–	–	
	Genset	yes	–	X	–	X	–	–	–	
	Rail	yes	–	X	–	X	–	–	–	

Series	Application	Cooling system containing light metals	Emulsions See chapter	Water-soluble corrosion inhibitors See chapter		Corrosion-inhibiting antifreezes See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
396 TC	Marine	yes	–	X	–	X[4]	–	–	–	[4] not permitted at seawater temperature > 20 °C !
	Genset	yes	–	X	–	X	–	–	–	
	C&I	yes	–	X	–	X	–	–	–	
	Rail	yes	–	X	–	X	–	–	–	
396 TE	Marine	yes	–	X	–	X[5]	–	–	–	[5] not permitted at seawater temperature > 20 °C !
	Genset	yes	–	X	–	X	–	–	–	
	C&I	yes	–	X	–	X	–	–	–	
	Rail	yes	–	X	–	X	–	–	–	
538	Marine	yes	X	–	–	–	–	–	–	
595	Marine	yes	X	–	–	–	–	–	–	
956-01/ 956-02	Marine	yes	X	X	–	–	–	–	–	Heating unit
	Genset	yes	X	X	–	X	–	–	–	
20V956 TB33	Genset[6]	yes	X	–	–	–	–	–	–	[6] up to year of manufacture end of 2008, in acc. with identification plate
	Genset[7]	yes	X	X	–	X	–	–	–	[7] from year of manufacture 2009, in acc. with identification plate
12V/16V 956 TB33	Genset	yes	X	X	–	X	–	–	–	
956 TB34	Genset	yes	X	X	–	X	–	–	–	
1163-02	Marine	yes	X	X	–	–	–	–	–	
	Genset	yes	X	X	–	X	–	–	–	

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Series	Application	Cooling system containing light metals	Emulsions See chapter	Water-soluble corrosion inhibitors See chapter		Corrosion-inhibiting antifreezes See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
1163-03/ 1163-04	Marine	yes	X	–	–	–	–	–	–	
2000 (incl. model type 06)	Marine	yes	–	X	–	X[8)]	–	X[8)]	–	[8)] not permitted at seawater temperature > 25 °C if a heat exchanger is installed on the engine
	Genset	yes	–	X	–	X	–	X	–	
	C&I	no	–	–	X	–	X	X	X	
	Oil&Gas (S-engines)	no	–	–	X	–	X	X	–	
	Oil&Gas (P-engines)	yes	–	X	–	X	–	X	–	
2000-07	Genset	yes	–	X	–	X	–	X	–	
4000-00/ 4000-01	Marine	yes	–	X	–	X[9)]	–	–	–	[9)]not permitted at seawater temperature > 25 °C if a heat exchanger is installed on the engine

Series	Application	Cooling system containing light metals	Emulsions See chapter	Water-soluble corrosion inhibitors See chapter		Corrosion-inhibiting antifreezes See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
4000-01/ 4000-02/ 4000-03	Genset	no	–	–	X	–	X	–	X	
	C&I	no	–	–	X	–	X	–	X	
	Rail	no	–	–	X	–	X	–	X	In the case of engines with no light metal components but with an external cooling system containing light metal, the coolant approvals for cooling systems containing light metal shall apply.
4000-01	Oil&Gas	yes: P11, P61, P81, P91	–	X	–	X	–	–	–	
4000-02/ 4000-03	Oil&Gas	no	–	–	X	–	X	–	X	
4000-00	Rail	yes	–	X	–	X	–	–	–	
4000-03	Marine	no	–	–	X	–	X[10)]	–	X	[10)]not permitted at seawater temperature > 25 °C if a heat exchanger is installed on the engine

Series	Application	Cooling system containing light metals	Emulsions See chapter	Water-soluble corrosion inhibitors See chapter		Corrosion-inhibiting antifreezes See chapter			Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
4000-04	Marine	no	–	–	X	–	X[11,12]	–	–	[11]not permitted at seawater temperature > 25 °C if a heat exchanger is installed on the engine [12] for products, see information in chapter 9.6
	Rail	no	–	–	–	–	X[13]	–	–	In the case of engines with no light metal components but with an external cooling system containing light metal, the coolant approvals for cooling systems containing light metal shall apply. [13] for products, see information in chapter 9.6
	Oil&Gas	no	–	–	–	–	X[14]	–	–	[14] for products, see information in chapter 9.6
	C&I	no	–	–	–	–	X[15]	–	–	[15] for products, see information in chapter 9.6

Series	Application	Cooling system containing light metals	Emulsions See chapter	Water-soluble corrosion inhibitors See chapter		Corrosion-inhibiting antifreezes See chapter				Remarks
			9.2	9.3	9.4	9.5	9.6	9.9.1	9.9.2	
4000	Gas engine	yes	–	X	–	X	–	X	–	
8000	Marine	yes	X	X	–	–	–	–	–	

Table 83:

Detroit Diesel four-cycle and two-cycle engines

X = application approval

– = no application approval

Series	Application	Cooling system containing light metals	Emulsions See chapter	Water-soluble corrosion inhibitors See chapter		Corrosion-inhibiting antifreezes See chapter		Remarks
			9.2	9.7.3/ 9.7.4	9.8.3/ 9.8.4	9.7.1/ 9.7.2	9.8.1/ 9.8.2	
S 60	Marine		–	X	–	X	–	Four-cycle engines
S 53	Marine C&I Genset	no	–	–	X	–	X	Two-cycle engines
S 71		no	–	–	X	–	X	Two-cycle engines
S 92		no	–	–	X	–	X	Two-cycle engines
S 149		no	–	–	X	–	X	Two-cycle engines

Table 84:

9.2 Emulsifiable corrosion-inhibiting oils

For details and special features, see chapter on “Coolants”(→ Page 23)

Emulsifiable corrosion-inhibiting oils

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Houghton Deutschland GmbH	Oil 9156	6000 / 1	X00056748 (barrel) X00056749 (canister)

Table 85:

9.3 Water-soluble corrosion inhibitors for cooling systems containing light metal

9.3.1 Water-soluble corrosion inhibitor concentrates for cooling systems containing light metal

For details and special features, see chapter on "Coolants"(→ Page 23)

Water-soluble corrosion inhibitor concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) also available through MTU Asia
MTU America Inc.	Power Cool® Plus 6000 Concentrate		X				6000 / 2	colored green 23533526 (1 gallon) 23533527 (5 gallons) available through MTU America
Arteco NV	Freecor NBI		X				6000 / 2	
BASF SE	Glysacorr G93-94		X				6000 / 2	X00054105 (barrel) X00058062 (canister)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	X				X	6000 / 2	
CCI Corporation	A 216	X				X	6000 / 2	
CCI Manufacturing IL Corporation	A 216	X				X	6000 / 2	X00051509 (208 l)
Chevron Corp.	Texcool A – 200		X				6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 6000	X				X	6000 / 2	colored red
Drew Marine	Drewgard XTA		X				6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X	6000 / 2	
Ginouves	York 719		X				6000 / 2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X	6000 / 2	
Valvoline	ZEREX G-93		X				6000 / 2	

Table 86:

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9.3.2 Water-soluble corrosion inhibitor ready mixtures for cooling systems containing light metal

For details and special features, see chapter on "Coolants"(→ Page 23)

Water-soluble corrosion-inhibiting antifreezes ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS10/90 Corrosion Inhibitor Premix		X				6000 / 2	

Table 87:

9.4 Water-soluble Corrosion Inhibitor Concentrates for Cooling Systems not Containing Light Metal

9.4.1 Water-soluble corrosion inhibitor concentrates for cooling systems not containing light metal

For details and special features, see chapter on "Coolants"(→ Page 23)

Water-soluble corrosion inhibitor concentrates for cooling systems not containing light metal

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) also available through MTU Asia
MTU America Inc.	Power Cool® Plus 6000 Concentrate		X				6000 / 2	colored green 23533526 (1 gallon) 23533527 (5 gallons) available through MTU America
Arteco NV	Freecor NBI		X				6000 / 2	
	Havoline Extended Life Corrosion Inhibitor [EU Code 32765] (XLI)	X					6000 / 2	
BASF SE	Glysacorr G93-94		X				6000 / 2	X00054105 (barrel) X00058062 (canister)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	X				X	6000 / 2	
CCI Corporation	A 216	X				X	6000 / 2	
CCI Manufacturing IL Corporation	A 216	X				X	6000 / 2	X00051509 (208 l)
Chevron Corp.	Texcool A – 200		X				6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 2000		X	X			6000 / 2	
	Power Cool Plus 6000	X				X	6000 / 2	colored red
Drew Marine	Drewgard XTA		X				6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X	6000 / 2	
Fleetguard	DCA-4L		X	X	X		2000 / 1	
Ginouves	York 719		X				6000 / 2	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Nalco	Alfloc (Maxitreat) 3477	X					6000 / 2	
	Alfloc 2000		X	X			6000 / 2	
	Nalco 2000		X	X			6000 / 2	
	Nalcool 2000		X	X			6000 / 2	
	Trac 102		X	X			6000 / 2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X	6000 / 2	
Penray	Pencool 2000		X	X			6000 / 2	
Total	Total WT Supra	X					6000 / 2	
Valvoline	Zerex G-93		X				6000 / 2	

Table 88:

9.4.2 Water-soluble corrosion inhibitor ready mixtures for cooling systems not containing light metals

For details and special features, see chapter on "Coolants"(→ Page 23)

Water-soluble corrosion inhibitor ready mixtures for cooling systems not containing light metals

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS 10/90 Corrosion Inhibitor Premix		X				6000 / 2	
Nalco	Alfloc (Maxitreat) 3443 (7%)	X					6000 / 2	

Table 89:

9.5 Corrosion Inhibitor and Antifreeze for Cooling Systems Containing Light Metal

9.5.1 Corrosion-inhibiting antifreeze concentrates for cooling systems containing light metal

For details and special features, see chapter on "Coolants"(→ Page 23)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100 Anti-freeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) also available through MTU Asia
MTU America Inc.	Power Cool® Off Highway Coolant Concentrate		X	X			9000 / 5	23533522 (1 gallon) 23533523 (5 gallons) 23533524 (55 gallons) available through MTU America
MTU Detroit Diesel Australia	Power Cool - HB500 Coolant Concentrate	X	X				9000 / 3	
Avia Mineralöl AG	Antifreeze APN	X	X				9000 / 5	
BASF SE	Glysantin G05		X	X			9000 / 5	
	Glysantin G48	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glysantin G30	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
BayWa AG	Tectrol Coolprotect	X	X				9000 / 5	
BP Lubricants	Aral Antifreeze Extra	X	X				9000 / 5	
	Castrol Heavy Duty Ex-tended Life Coolant	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48	X	X				9000 / 5	
Castrol	Castrol Antifreeze NF	X	X				9000 / 5	
	Castrol Radicool NF	X	X				9000 / 5	
Clariant	Genantin Super		X	X			9000 / 5	
Classic Schmierstoff GmbH + Co KG	Classic Kolda UE G48	X	X				9000 / 5	
CCI Corporation	L 415	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521	X				X	9000 / 3	
Comma Oil & Chemi-cals Ltd.	Comma Xstream G30	X					9000 / 3	
	Comma Xstream G48	X	X				9000 / 5	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant	X				X	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X	9000 / 3	
	Mobil Antifreeze Advanced	X					9000 / 3	
	Mobil Antifreeze Extra	X	X				9000 / 5	
	Mobil Antifreeze Special		X	X			9000 / 5	
	Esso Antifreeze Advanced	X					9000 / 3	
	Esso Antifreeze Extra	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin	X	X				9000 / 5	
	Maintain Fricofin G12 Plus	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
Ginouves	York 716	X	X				9000 / 5	
Krafft S.L.U.	Refrigerante ACU 2300		X	X			9000 / 3	X00058075 (barrel)
INA Maziva Ltd.	INA Antifriz Al Super	X	X				9000 / 5	
Mol-Lub Kft	EVOX Extra G48 Antifreeze concentrate	X	X				9000 / 5	
Nalco	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48	X	X				9000 / 5	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X	9000 / 3	
	Fleetcharge SCA Precharged Heavy Duty Coolant/ Antifreeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze	X				X	9000 / 3	
OMV	OMV Coolant Plus	X	X				9000 / 5	
	OMV Coolant SF	X					9000 / 3	
Recochem Inc.	R542	X	X				9000 / 3	
SMB - Sotagal / Mont Blanc	Antigel Power Cooling Concentrate	X	X				9000 / 5	
Total	Glacelf MDX	X	X				9000 / 5	
Valvoline	Zerex G-05		X	X			9000 / 5	
	Zerex G-48	X	X				9000 / 5	
	Zerex G-30	X					9000 / 3	

Table 90:

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9.5.2 Corrosion-inhibiting antifreeze concentrates for special applications

For details and special features, see chapter on "Coolants"(→ Page 23)

Concentrates for special applications

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
BASF SE	G206		X	X			9000 / 3	For use in arctic regions (< -40 °C)

Table 91:

9.5.3 Corrosion-inhibiting antifreeze ready mixtures for cooling systems containing light metal

For details and special features, see chapter on "Coolants"(→ Page 23)

Ready mixtures for cooling systems containing light metals

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH 35/65 Antifreeze Premix	X	X				9000 / 5	
MTU America Inc.	Power Cool ®Universal 35/65 mix	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool ® Universal 50/50 mix	X	X				9000 / 5	800069 (1 gallon) 800071 (5 gallons) 800084 (55 gallons)
	Power Cool ® Off-Highway Coolant 50/50 Premix		X	X			9000 / 5	23533530 (1 gallon) 23533531 (5 gallons) 23533532 (55 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
Bantleon	Avilub Antifreeze Mix (50%)	X	X				9000 / 5	X00049213 (210 l)
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)	X	X				9000 / 5	
Castrol	Castrol Antifreeze NF Premix (45%)	X	X				9000 / 5	
	Castrol Radicool NF Premix (45%)	X	X				9000 / 5	
CCI Corporation	L 415 (50%)	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	X				X	9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	X				X	9000 / 3	
Exxon Mobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/Antifreeze (50/50)	X				X	9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44%)	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)	X	X				9000 / 5	
Total	Coolelf MDX (40%)	X	X				9000 / 5	
Tosol-Sintez	Glysantin Alu Protect G30 Ready Mix	X					9000 / 3	
	Glysantin Alu Protect Plus G48 Ready Mix	X	X				9000 / 5	
Valvoline	Zerex G-05 50/50 Mix		X	X			9000 / 5	

Table 92:

9.6 Corrosion Inhibitor and Antifreeze for Cooling Systems not Containing Light Metal

9.6.1 Corrosion-inhibiting antifreeze concentrates for cooling systems not containing light metal

For details and special features, see chapter on "Coolants"(→ Page 23)

For the Series 4000-04, only coolants marked with an asterisk * can be used!

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100* Anti-freeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) also available through MTU Asia
MTU America Inc.	Power Cool® Off-Highway Coolant Concentrate		X	X			9000 / 5	23533522 (1 gallon) 23533523 (5 gallons) 23533524 (55 gallons) available through MTU America
MTU Detroit Diesel Australia	Power Cool - HB500	X	X				9000 / 3	
	Power Cool - HB800	X	X	X			9000 / 3	
Arteco NV	Havoline Extended Life Coolant XLC [EU Code 30379]	X					9000 / 3	
Avia Mineralöl AG	Antifreeze APN*	X	X				9000 / 5	
BASF SE	Glysantin G05		X	X			9000 / 5	
	Glysantin G48*	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glysantin G30*	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
BayWa AG	Tectrol Coolprotect*	X	X				9000 / 5	
BP Lubricants	ARAL Antifreeze Extra*	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant*	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48*	X	X				9000 / 5	
Caltex	Caltex Extended Life Coolant [AP Code 510614] (XLC)	X					9000 / 3	
Castrol	Castrol Antifreeze NF*	X	X				9000 / 5	
	Castrol Radicool NF*	X	X				9000 / 5	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
CCI Corporation	L415*	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C521*	X				X	9000 / 3	
Chevron Corp.	Havoline Dexcool Extended Life Antifreeze [US Code 227994]	X					9000 / 3	
Clariant	Genantin Super		X	X			9000 / 3	
Classic Schmierstoff GmbH + Co. KG	Classic Kolda UE G48*	X	X				9000 / 5	
Comma Oil & Chemicals Ltd.	Comma Xstream G30*	X					9000 / 3	
	Comma Xstream G48*	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant*	X				X	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant*	X				X	9000 / 3	
	Mobil Antifreeze Advanced*	X					9000 / 3	
	Mobil Antifreeze Extra*	X	X				9000 / 5	
	Mobil Antifreeze Special		X	X			9000 / 5	
	Esso Antifreeze Advanced*	X					9000 / 3	
	Esso Antifreeze Extra*	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin*	X	X				9000 / 5	
	Maintain Fricofin G12 Plus*	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
	Maintain Fricofin HDD [Oilcode T-AF3-1]		X	X		X	9000 / 3	
Gazpromneft - Lubricants Ltd.	G - Energy Antifreeze SNF	X					9000 / 3	
Ginouves	York 716*	X	X				9000 / 5	
Krafft S.L.U	Refrigerante ACU 2300		X	X			9000 / 3	X00058075 (barrel)
INA Maziva Ltd.	INA Antifriz AI Super*	X	X				9000 / 5	
MOL-Lub Kft.	EVOX Extra G48 Antifreeze concentrate	X	X				9000 / 5	
	EVOX Premium concentrate	X					9000 / 3	
Nalco	Nalcool 4070	X	X	X			9000 / 3	
	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48*	X	X				9000 / 5	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
OAO Technoform	Cool Stream Premium C	X					9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant*	X				X	9000 / 3	
	Fleetcharge SCA Precharged Heavy Duty Coolant/ Antifreeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze*	X				X	9000 / 3	
OMV	OMV Coolant Plus*	X	X				9000 / 5	
	OMV Coolant SF*	X					9000 / 3	
Recochem Inc.	R542	X	X				9000 / 3	
	R824M	X	X	X			9000 / 3	
Shell	Shell HD Premium N		X	X			9000 / 3	
SMB - Sotragal / Mont Blanc	Antigel Power Cooling Concentrate*	X	X				9000 / 5	
Total	Glacelf Auto Supra	X					9000 / 3	
	Glacelf MDX*	X	X				9000 / 5	
	Glacelf Supra	X					9000 / 3	
Valvoline	Zerex G-05		X	X			9000 / 5	
	Zerex G-48*	X	X				9000 / 3	
	Zerex G-30*	X					9000 / 5	

Table 93:

9.6.2 Corrosion-inhibiting antifreeze concentrates for special applications

For details and special features, see chapter on "Coolants"(→ Page 23)

Concentrates for special applications

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
BASF SE	G206		X	X			9000 / 3	For use in arctic regions (< -40 °C) no approval for Series 4000-04

Table 94:

9.6.3 Corrosion-inhibiting antifreeze ready mixtures for cooling systems not containing light metal

For details and special features, see chapter on "Coolants"(→ Page 23)

For the Series 4000-04, only coolants marked with an asterisk * can be used!

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH 35/65 Anti-freeze Premix*	X	X				9000 / 5	
MTU America Inc.	Power Cool® Universal 35/65 mix*	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal 50/50 mix*	X	X				9000 / 5	800069 (1 gallon) 800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off-Highway Coolant 50/50 Premix		X	X			9000 / 5	23533530 (1 gallon) 23533531 (5 gallons) 23533532 (55 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500 Pre-mix 50/50	X	X				9000 / 3	
	Power Cool - HB800 Pre-mix 50/50	X	X	X			9000 / 3	
Arteco NV	Halvoline Extended Life Coolant + B2 50/50 OF01 [EU Code 33073] (50%)	X					9000 / 3	
	Halvoline Extended Life Coolant + B2 40/60 OF01 [EU Code 33069] (40%)	X					9000 / 3	
	Halvoline Extended Life Coolant + B2 35/65 OF01 [EU Code 33074] (35%)	X					9000 / 3	
Bantleon	Avilub Antifreeze Mix (50%)*	X	X				9000 / 5	X00049213 (210 l)
BP Lubricants	Castrol Heavy Duty Ex-tended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)*	X	X				9000 / 5	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Caltex	Caltex Extended Life Coolant Pre-Mixed 50/50 [AP Code 510609] (50%)	X					9000 / 3	
Castrol	Castrol Antifreeze NF Premix (45%)*	X	X				9000 / 5	
	Castrol Radicool NF Premix (45%)*	X	X				9000 / 5	
CCI Corporation	L 415 (50%)*	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)*	X				X	9000 / 3	
Chevron Corp.	Havoline Dexcool Extended Life Predilluted 50/50 Antifreeze Coolant [US Code 227995]	X					9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)*	X				X	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
Fuchs Petrolub SE	Maintain Fricofin HDD Premix 50/50 [Oilcode T-AF3-2]		X	X		X	9000 / 3	
Nalco	Nalcool 4100 (50%)	X	X	X			9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
	Final Charge Global Extended Life Predilluted Coolant / Antifreeze (50/50)*	X				X	9000 / 3	
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44%)*	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)*	X	X				9000 / 5	
Total	Coolelf MDX (40%)*	X	X				9000 / 5	
	Coolelf Supra (40%)	X					9000 / 3	
	Coolelf GF NP (50%)	X					9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Tosol-Sinzez	Glysantin Alu Protect/G30 Ready Mix*	X					9000 / 3	
	Glysantin Protect Plus/G48 Ready Mix*	X	X				9000 / 5	
Valvoline	Zerex G-05 50/50 Mix		X	X			9000 / 5	

Table 95:

9.7 Coolant Additives for Series 60 Engines

9.7.1 Corrosion inhibiting antifreeze concentrates for Series 60 engines

For details and special features, see chapter on "Coolants"(→ Page 23)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100 Anti-freeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) also available through MTU Asia
MTU America Inc.	Power Cool® Off-Highway Coolant Concentrate		X	X			9000 / 5	23533522 (1 gallon) 23533523 (5 gallons) 23533524 (55 gallons) available through MTU America
MTU Detroit Diesel Australia	Power Cool - HB500	X	X				9000 / 3	
Avia Mineralöl AG	Antifreeze APN	X	X				9000 / 5	
BASF SE	Glysantin G05		X	X			9000 / 5	
	Glysantin G30	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
	Glysantin G48	X	X				9000 / 5	X00058054 X00058053
BayWa AG	Tectrol Coolprotect	X	X				9000 / 5	
BP Lubricants	Aral Antifreeze Extra	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48	X	X				9000 / 5	
Castrol	Castrol Antifreeze NF	X	X				9000 / 5	
	Castrol Radicool NF	X	X				9000 / 5	
Classic Schmierstoff GmbH + Co KG	Classic Kolda UE G48	X	X				9000 / 5	
Comma Oil & Chemicals Ltd.	Comma Xstream G30	X					9000 / 3	
	Comma Xstream G48	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant	X				X	9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X	9000 / 3	
	Mobil Antifreeze Advanced	X					9000 / 3	
	Mobil Antifreeze Extra	X	X				9000 / 5	
	Mobil Antifreeze Special		X	X			9000 / 5	
	Esso Antifreeze Advanced	X					9000 / 3	
	Esso Antifreeze Extra	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin	X	X				9000 / 5	
	Maintain Fricofin G 12 Plus	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
INA Maziva Ltd.	INA Antifriz Al Super	X	X				9000 / 5	
Mol-Lub Kft	Evox Extra G48 Antifreeze concentrate	X	X				9000 / 5	
Nalco	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48	X	X				9000 / 5	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X	9000 / 3	
	Fleet Charge SCA precharged heavy duty coolant / Antifreeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant/ Antifreeze	X				X	9000 / 3	
OMV	OMV Cooland Plus	X	X				9000/5	
	OMV Coolant SF	X					9000 / 3	
Recochem Inc.	R 542	X	X				9000 / 3	
SMB - Sotagal / Mont Blanc	Antigel Power Cooling Concentrate	X	X				9000 / 5	
Total	Glacelf MDX	X	X				9000 / 5	
Valvoline	Zerex G 05		X	X			9000 / 5	
	Zerex G-48	X	X				9000 / 5	
	Zerex G 30	X					9000 / 3	

Table 96:

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9.7.2 Corrosion-inhibiting antifreeze ready mixtures for Series 60 engines

For details and special features, see chapter on "Coolants" (→ Page 23)

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH 35/65 Antifreeze Premix	X	X				9000 / 5	
MTU America Inc.	Power Cool® Universal (35/65)	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal (50/50)	X	X				9000 / 5	800069 (1 gallon) 800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off Highway 50/50		X	X			9000 / 5	23533530 (1 gallon) 23533531 (5 gallons) 23533532 (55 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
Bantleon	Avilub Antifreeze Mix (50%)	X	X				9000 / 5	X00049213 (210 l)
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)	X	X				9000 / 5	
Castrol	Castrol Antifreeze NF Premix (45%)	X	X				9000 / 5	
	Castrol Radicool NF Premix (45%)	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	X				X	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/Antifreeze (50/50)	X				X	9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44%)	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)	X	X				9000 / 5	
Total	Coolelf MDX (40%)	X	X				9000 / 5	
Tosol-Sintez	Glysantin Alu Protect G30 Ready Mix	X					9000 / 3	
	Glysantin Alu Protect G48 Ready Mix	X	X				9000 /5	
Valvoline	Zerex G-05 50/50 Mix		X	X			9000 / 5	

Table 97:

9.7.3 Corrosion-inhibiting antifreeze concentrates for Series 60 engines

For details and special features, see chapter on "Coolants" (→ Page 23)

Water-soluble corrosion inhibitor concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) also available through MTU Asia
MTU America Inc.	Power Cool® Plus 6000 Concentrate		X				6000 / 2	colored green 23533526 (1 gallon) 23533527 (5 gallons) available through MTU America
BASF SE	Glysacorr G93-94		X				6000 / 2	X00054105 (barrel) X00058062 (canister)
Drew Marine	Drewgard XTA		X				6000 / 2	
Ginouves	York 719		X				6000 / 2	
Valvoline	ZEREX G-93		X				6000 / 2	

Table 98:

9.7.4 Water-soluble corrosion inhibitor ready mixtures for Series 60 engine

For details and special features, see chapter on "Coolants"(→ Page 23)

Water-soluble corrosion-inhibiting antifreezes ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS 10/90 Corrosion Inhibitor Premix		X				6000 / 2	

Table 99:

9.8 Coolant Additives for Two-Cycle Engines

9.8.1 Corrosion-inhibiting antifreeze concentrates for two-cycle engines

For details and special features, see chapter on "Coolants" (→ Page 23)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100 Anti-freeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) also available through MTU Asia
MTU America Inc.	Power Cool® 3149	X		X			9000 / 5	23528572 23528571
MTU Detroit Diesel Australia	Power Cool - HB500	X	X				9000 / 3	
Avia Mineralöl AG	Antifreeze APN	X	X				9000 / 5	
BASF SE	Glysantin G30	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
	Glysantin G48	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
BayWa AG	Tectrol Coolprotect	X	X				9000 / 5	
BP Lubricants	Aral Antifreeze Extra	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48	X	X				9000 / 5	
Castrol	Castrol Antifreeze NF	X	X				9000 / 5	
	Castrol Radicool NF	X	X				9000 / 5	
CCI Corporation	L 415	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521	X				X	9000 / 3	
Classic Schmierstoff GmbH + Co. KG	Classic Kolda UE G48	X	X				9000 / 5	
Comma Oil & Chemicals Ltd.	Comma Xstream G30	X					9000 / 3	
	Comma Xstream G48	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant	X				X	9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X	9000 / 3	
	Mobil Antifreeze Advanced	X					9000 / 3	
	Mobil Antifreeze Extra	X	X				9000 / 5	
	Esso Antifreeze Advanced	X					9000 / 3	
	Esso Antifreeze Extra	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin	X	X				9000 / 5	
	Maintain Fricofin G12 Plus	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
Ginouves	York 716	X	X				9000 / 5	
INA Maziva Ltd.	INA Antifriz Al Super	X	X				9000 / 5	
MOL-Lub Kft.	EVOX Extra G48 Antifreeze concentrate	X	X				9000 / 5	
Nalco	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48	X	X				9000 / 5	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X	9000 / 3	
	Fleet Charge SCA precharged heavy duty coolant / Antifreeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant/ Antifreeze	X				X	9000 / 3	
OMV	OMV Coolant Plus	X	X				9000 / 5	
	OMV Coolant SF	X					9000 / 3	
Recochem Inc.	R 542	X	X				9000 / 3	
SMB - Sotragal / Mont Blanc	Antigel Power Cooling Concentrate	X	X				9000 / 5	
Total	Glacelf MDX	X	X				9000 / 5	
Valvoline	Zerex G-30	X					9000 / 3	
	Zerex G-48	X	X				9000 / 5	

Table 100:

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9.8.2 Corrosion-inhibiting antifreeze ready mixtures for two-cycle engines

For details and special features, see chapter on "Coolants" (→ Page 23)

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen	Coolant AH 35/65 Anti-freeze Premix	X	X				9000 / 5	
MTU America Inc.	Power Cool® Universal 35/65 mix	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal 50/50 mix	X	X				9000 / 5	800069 (1 gallon) 800071 (5 gallons) 800084 (55 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500 Pre-mix 50/50	X	X				9000 / 3	
Bantleon	Avilub Antifreeze Mix (50%)	X	X				9000 / 5	X00049213 (210 l)
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)	X	X				9000 / 5	
Castrol	Castrol Antifreeze NF Premix (45%)	X	X				9000 / 5	
	Castrol Radicool NF Premix (45%)	X	X				9000 / 5	
CCI Corporation	L 415 (50%)	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	X				X	9000 / 3	
Detroit Diesel Corp.	Power Cool Antifreeze premix 50/50		X	X			9000 / 3	
	Power Cool Plus Prediluted Coolant (50/50)	X				X	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44%)	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)	X	X				9000 / 5	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/Antifreeze (50/50)	X				X	9000 / 3	
Tosol-Sintez	Glysantin Alu Protect/G30 Ready Mix	X					9000 / 3	
	Glysantin Protect Plus/G48 Ready Mix	X	X				9000 / 5	
Total	Coolelf MDX (40%)	X	X				9000 / 5	

Table 101:

9.8.3 Water-soluble corrosion inhibitor concentrates for two-cycle engines

For details and special features, see chapter on "Coolants" (→ Page 23)

Water-soluble corrosion inhibitor concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) also available through MTU Asia
MTU America Inc.	Power Cool® Plus 6000 Concentrate		X				6000 / 2	colored green 23533527 (1 gallons) 23533526 (5 gallons)
Arteco NV	Freeco NBI		X				6000 / 2	
BASF SE	Glysacorr G93-94		X				6000 / 2	X00058062 (canister) X00054105 (barrel)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	X				X	9000 / 2	
CCI Corporation	A 216	X				X	6000 / 2	
CCI Manufacturing IL Corporation	A 216	X				X	6000 / 2	X00051509 (208 l)
Chevron Corp.	Texcool A – 200		X				6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 6000	X				X	6000 / 2	colored red
	Power Cool 2000		X	X			6000 / 2	
	Power Cool 3000		X	X	X		4000 / 2	
Drew Marine	Drewgard XTA		X				6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X	6000 / 2	
Ginouves	York 719		X				6000 / 2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X	6000 / 2	
Penray	Pencool 2000		X	X			6000 / 2	
	Pencool 3000		X	X	X		4000 / 2	
Valvoline	ZEREX G-93		X				6000 / 2	

Table 102:

9.8.4 Water-soluble corrosion inhibitor ready mixtures for two-cycle engines

For details and special features, see chapter on "Coolants"(→ Page 23)

Water-soluble corrosion-inhibiting antifreezes ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS 10/90 Corrosion Inhibitor Premix		X				6000 / 2	

Table 103:

9.9 Coolant additives with limited series release

9.9.1 Corrosion-inhibiting antifreeze concentrates based on ethylene glycol (suitable for series with and without light alloys)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
BASF SE	Glysantin®G40 (concentrate)	X	X				9000 / 3	X00066724 (20 l) X00066725 (210 l) Concentration for use: 40-50% by volume
Valvoline	ZEREX G40 (concentrate)	X	X				9000 / 3	Concentration for use: 40-50% by volume

Table 104:

9.9.2 Corrosion-inhibiting antifreeze ready mixture based on propylene glycol for series free of light metal

Corrosion-inhibiting antifreeze ready mixture

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Part No.
		Organic	Silicium	Nitrite	Phosphatized	Molybdate		
Fleetguard	PG XL (40%) ready mixture		X	X	X		9000 / 3	

Table 105:

10 Flushing and Cleaning Specifications for Engine Coolant Circuits

10.1 General information

These cleaning specifications are for the engine coolant circuits in MTU diesel engines and gas engines.

In the course of time, sludge deposits from aging coolant additives can accumulate in the coolant circuits. Reduced cooling capacity, clogged vent lines and drain points and dirty coolant level sight-glasses can result.

Below-standard water quality or incorrect coolant preparation can also heavily contaminate the system.

If such conditions occur, the coolant circuit is to be flushed out with fresh water, repeatedly if necessary.

If these flushing sequences are insufficient or if the system is too heavily contaminated, the coolant circuit and all affected parts must be cleaned.

Only clean, fresh water (no river or sea water) must be used for flushing.

Only MTU-approved or corresponding products at the specified concentrations may be used for cleaning. The specified cleaning procedure is to be complied with.

Immediately after flushing or cleaning, fill the coolant circuits with treated engine coolant as stipulated in the current MTU Fluids and Lubricants Specifications A001061/.. (→ Page 117). Otherwise there is a danger of corrosion!

Fluids and lubricants (e.g. treated engine coolant), used flushing water, cleaning agents and cleaning solutions can be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.
These regulations are contained in the manufacturer's instructions, legal requirements and technical guidelines valid in the individual countries. Considerable differences can apply from country to country so that no generally valid statement on the applicable regulations for fluids and lubricants etc. can be made in this publication.
Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants / cleaning agents which it has approved.

Scrap oil heat exchangers from engines with bearing or piston seizures or friction damage!

Test equipment, auxiliary materials and fluids and lubricants

MTU test kit or electric pH-value measuring instrument
- Fresh water
- Prepared engine coolant
- Superheated steam
- Compressed air

10.2 Approved cleaning agents

Manufacturer	Product name	Concentration for use		Order no.
For coolant systems:				
Kluthe	Hakutex 111 [1, 8)]	2% by volume	Liquid	X00065751
	Hakupur 50-706-3 [8)]	2% by volume	Liquid	X00055629
Nalco	Maxi Clean 2 [1, 8)]	2% by volume	Liquid	[7)]
For assemblies:				
Henkel	P3-FD [2)]	3 to 5% by weight	Powder	[7)]
	Porodox [3)]	5 to 10% by weight	Powder	[7)]
Kluthe	Hakutex 60	100% by volume	Liquid	X00056750 (25kg)
For coolant systems contaminated with bacteria, fungi or yeast (so-called system cleaners):				
Schülke & Mayr GmbH	Grotan WS Plus [5)]	0.15% by volume	Liquid	X00065326 (10kg)
	Grotanol SR1 [6)]	1% by volume	Liquid	X00057297 (10kg) X00057298 (200kg)
Troy Chemical Company	Troyshield SC1 [6)]	1% by volume	Liquid	[7)]

[1)] For light lime deposits, light corrosion

[2)] For greasy lime deposits

[3)] Preferred for heavy lime deposits

[4)] For heavy lime deposits

[5)] Bacteria contamination up to 10^4

[6)] Bacteria contamination up to > 10^4, contamination with fungi and yeast

[7)] Not stocked by MTU

[8)] Not suitable for galvanized surfaces

10.3 Engine coolant circuits – Flushing

1. Drain engine coolant.
2. Measure pH-value of the fresh water (MTU test kit or electric pH-value measuring device).
3. Fill coolant circuit with fresh water.

> Never pour cold water into a hot engine!

4. Preheat, start and run engine until warm.
5. Run engine for approx. 30 minutes at increased speed.
6. Take flush-water sample (engine-coolant-sample extraction cock).
7. Shut down engine.
8. Drain flush water.
9. Measure pH value of flush-water sample using the MTU test kit or electric pH value measuring device and compare with the pH value of the fresh water.
   a) pH value difference < 1: Fill system with treated coolant and start engine.
   b) pH value difference > 1: Fill system with fresh flush water and repeat flushing process.
   c) If the pH value difference is still > 1 after 4 to 5 flushing operations: The coolant circuit must be cleaned, see (→ Page 158). The assemblies may also have to be cleaned, see (→ Page 159).

> Refer to the engine Operating Instructions for additional information.

10.4 Engine coolant circuits - Cleaning

1. Detergent for coolant circuits is prepared in warm, fresh water as a concentrated solution, see (→ Page 156).
2. In the case of powdered products, stir until the detergent is completely dissolved and without sediment.
3. Pour solution together with fresh water into coolant circuit.
4. Start engine and run until warm.
5. Run engine for approx. 2 hours at increased speed.
6. Shut down engine.
7. Drain off cleaning agents and flush the engine coolant circuit with fresh water.
8. Take flush-water sample (engine-coolant-sample extraction cock).
9. Measure pH value of flush-water sample using the MTU test kit or electric pH value measuring device and compare with the pH value of the fresh water.
   a) pH value difference < 1: Fill system with treated coolant and start engine.
   b) pH value difference > 1: Clean assemblies, see (→ Page 159).

Refer to the engine Operating Instructions for additional information.

10.5 Cleaning assemblies

1. Remove, disassemble and clean assemblies that are exposed to heavy sludge deposits e.g. expansion tanks, preheating units, heat exchangers (coolant cooler, oil heat-exchanger, intercooler, charge-air preheater, fuel preheater etc.) and lower sections of pipework.
2. Before cleaning, examine degree of contamination on water sides.
3. If greasy lime deposits are found, first degrease the water side.
4. Deposits in intercoolers caused by oil mist can be removed using Kluthe Hakutex 60.
5. Remove hard lime deposits with a decalcifying product. In the event of stubborn lime deposits, a 10% inhibited hydrochloric acid solution may have to be used.
6. Dissolve deposits on and in heat-exchanger elements in a heated cleaning bath. Observe the manufacturer's specifications and use only approved detergents in the permissible concentration, see (→ Page 156)

   Deposits on the oil side can also be dissolved in a kerosene bath.
   The dwell time in the cleaning bath depends on the type and degree of contamination, as well as the temperature and activity of the bath.

7. Clean individual components such as housings, covers, pipes, sight glasses, heat-exchanger elements with superheated steam, a nylon brush (soft) and a powerful water jet.

   In order to avoid damage:
   Do not use hard or sharp-edged tools (steel brushes, scrapers, etc.) (oxide protective layer).
   Do not set the pressure of the water jet too high (may damage cooler fins, for example).

8. After cleaning, blow through the heat exchanger elements with low-pressure steam in the direction opposite to operational flow, rinse with clear water (until pH-value difference is < 1) and blow dry with compressed or hot air.
9. Check that all components are in perfect condition, repair or replace as necessary.
10. Flush oil and engine coolant sides of heat-exchanger elements with corrosion-inhibiting oil. This step may be omitted if the heat exchanger is installed and taken into service immediately after cleaning.
11. After installing all assemblies, flush engine coolant circuit once, see (→ Page 157).
12. Check coolant system for leaks during initial operation of engine.

    For further information, see the Maintenance Manual for the engine in question.

10.6 Coolant circuits contaminated with bacteria, fungi or yeast

System cleaning

The system cleaner must flow a sufficiently long time through the complete cooling system to ensure effective cleaning and disinfection.

Therefore, the predefined amount of the approved system cleaner must be added to the contaminated coolant in the system, see (→ Page 156). Use a circulating pump to provide continuous mixture flow through the coolant system for at least 24 hours.

Flushing

After draining the coolant/system cleaner mixture, the coolant circuit must be flushed with fresh water as long as visible contamination can be detected and until the flush water has the pH-value of the fresh water (maximum deviation of the pH-values: < 1).

Refill

Before refilling the circuit, make sure the system is free of contaminants.

Refill must be performed directly after flushing to avoid the risk of corrosion!

11 Overview of Changes

11.1 Revision overview from version A001061/35 to A001061/36

Ser. No.	Page	Chapter	Subsection	Action	Supplement/ comments
1	5	Preface		Revised	Internet address, reference to further fluids and lubricants specifications
2	7	Lubricants for four-stroke engines	Engine oils	Revised	complete subsection
3	16		Fluorescent dyestuffs for detecting leaks in the lube oil circuit	Addition	complete subsection
4	18	Lubricants for gas engines	Engine oils	Revised	complete chapter
5	20	Lubricants for two-cycle engines	Engine oils	Revised	complete chapter
6	23	Engine coolant	General information	Revised	
7	25		Unsuitable materials in the coolant circuit	Addition	complete subsection
8	26		Freshwater requirements	Revised	complete subsection
9	27		Emulsifiable corrosion-inhibiting oils	Revised	complete subsection
10	29		Corrosion-inhibiting antifreezes	Revised	complete subsection
11	31		Water-soluble corrosion inhibitors	Revised	complete subsection
12	32		Operational monitoring	Revised	complete subsection
13	36		Limit values for coolants	Addition	Note
14	37		Storage stability of coolant concentrates	Revised	table

Ser. No.	Page	Chapter	Subsection	Action	Supplement/ comments
15	38		Color additives for aqueous corrosion inhibiting antifreezes for detection of leaks in the coolant circuit	Addition	complete subsection
16	39	Fuels	Diesel fuels	Revised	complete subsection
17	44		Series-based approved diesel fuels for MTU engines	Addition	complete subsection
18	65		Diesel fuels for engines with exhaust aftertreatment	Addition	complete subsection
19	67		Biodiesel - biodiesel admixture	Addition	complete subsection
20	70		Heating oil EL	Revised	Update of standard validity
21	71		Supplementary fuel additives	Revised	complete subsection
22	73		Unsuitable materials in the coolant circuit	Addition	complete subsection
23	74		Fuel for gas engines	Revised	complete subsection
24	85	Approved engine oils and lubricating greases	Engine oils for four-cycle engines	Revised	complete subsection (8.1.1 - 8.1.10)
25	114		Engine oils for gas engines	Revised	only 1 subsection (8.2.1)
26	115		Engine oils for two-cycle engines	Revised	complete subsection (8.3.2)
27	117		Lubricating greases	Revised	Manufacturer's name
28	118	Approved coolants	Series- and application-based usability of coolant additives	Revised	complete subsection (9.1 - 9.2)
29	125		Water-soluble corrosion inhibitors for cooling systems containing light metal	Revised	complete subsection (9.3.1 - 9.3.2)

Ser. No.	Page	Chapter	Subsection	Action	Supplement/ comments
30	127		Water-soluble corrosion inhibitors for cooling systems containing no light metal	Revised	complete subsection (9.4.1 - 9.4.2)
31	130		Corrosion inhibitor and antifreeze for cooling systems containing light metal	Revised	complete subsection (9.5.1 - 9.5.3)
32	135		Corrosion inhibitor and antifreeze for cooling systems not containing light metal	Revised	complete subsection (9.6.1 - 9.6.3)
33	141		Coolant additives for Series 60 engines	Revised	complete subsection (9.7.1 - 9.7.4)
34	147		Coolant additives for two-cycle engines	Revised	complete subsection (9.8.1 - 9.8.4)
35	153		Coolant additives with limited series release	Addition	complete subsection (9.9.1 - 9.9.2)
36	155		Flushing and Cleaning Specifications for Engine Coolant Systems	Revised	subsection (10.2 - 10.6)
37	161	Revision overview	Revision overview from version A001061/35 to A001061/36	Revised	complete chapter

12 Appendix A

12.1 Index