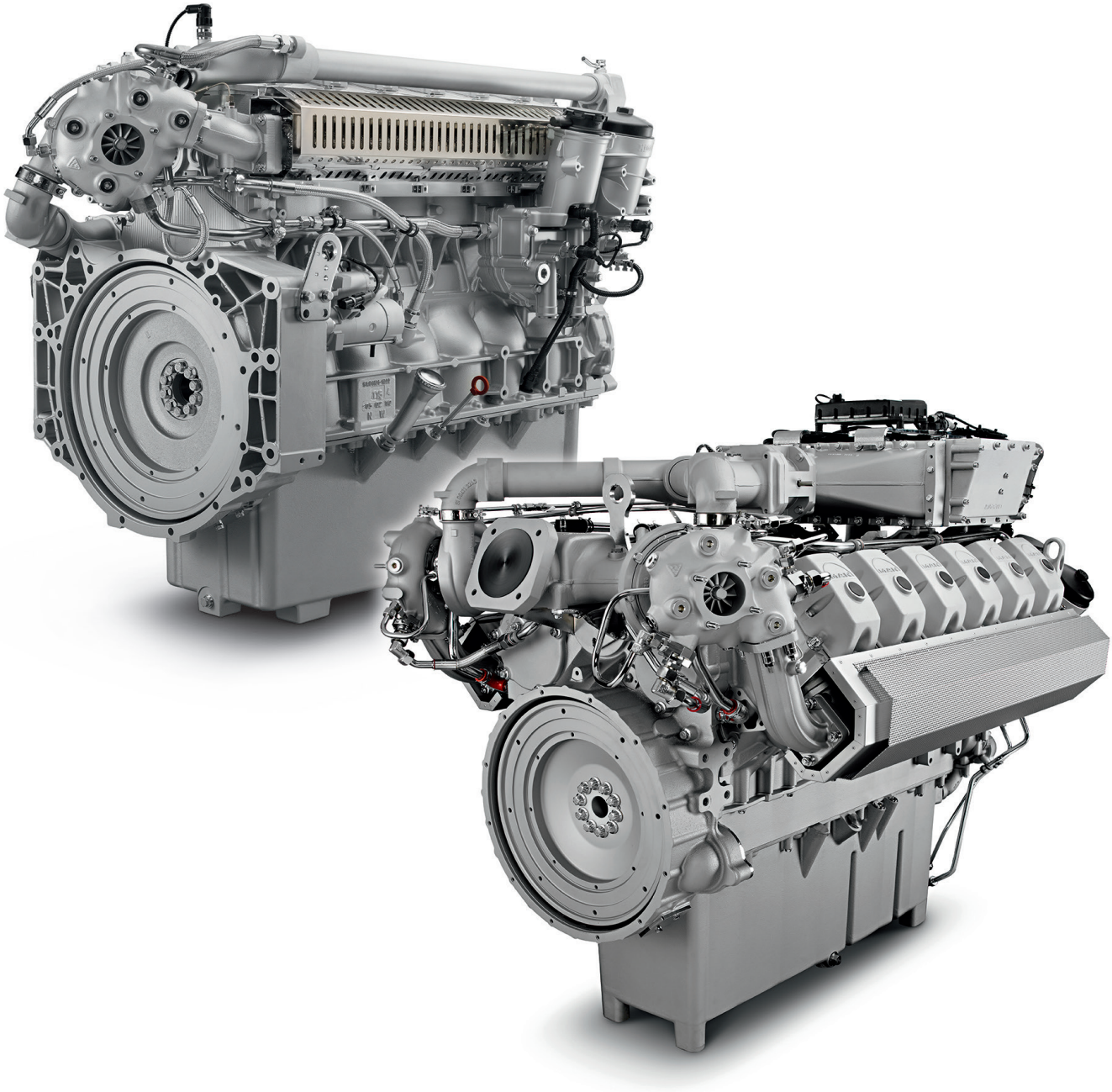

Service products

MAN Industrial Gas Engines

MAN Engines

Service products

MAN Industrial Gas Engines

51.99589-8002
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“Translation of the original instructions”

Imprint

We reserve the right to make technical modifications in the course of further development.

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Table of contents

1 Preface

1.1 Information

Dear customer,

MAN industrial gas engines are developed and manufactured using state-of-the-art technological standards and production plants.

This results in important characteristics, such as:

- Efficient operation through low fuel and lubricant consumption
- Low weight
- Low maintenance and spare parts requirements, as well as long service life
- Future-proof environmental sustainability
- Compact design

However, trouble-free operation and the expected high performance and service life can only be achieved if the prescribed service intervals are complied with using the service products that are approved by MAN.

Please observe the general safety information and in particular the “environmental protection rules” when handling service products.

Yours sincerely,
MAN Truck & Bus AG
Nuremberg Plant

1.2 Explanation of icons

Warning notices

Warning notices are marked in this publication with symbols for service products. The information has been introduced with signal words that express the extent of risk or danger.

Follow the instructions to the letter and proceed cautiously to prevent accidents, personal injury and material damage.

DANGER

Describes an immediate dangerous situation that will lead to severe injuries or death if it is not avoided.

WARNING

Describes a potentially dangerous situation that may lead to severe injuries or death if it is not avoided.

CAUTION

Describes a potentially dangerous situation that may lead to minor or moderate injuries if it is not avoided.

NOTE

Describes a potentially dangerous situation that may lead to damage to property if it is not avoided.

Tips and Recommendations

Tip for users

Tips and recommendations as well as information for efficient and trouble-free operation.

ENVIRONMENTAL NOTE

Tips on conduct for environmental protection.

General information.

- This symbol indicates a listing at the first level.

► This symbol indicates an action / sequence of actions.

1.3 Limitation on liability

All information and instructions in this manual have been compiled taking into consideration the applicable standards and regulations, the state-of-the-art technology as well as our knowledge and experience acquired over a period of several years.

MAN assumes no liability for damage due to:

- Failure to observe these instructions
- Improper use
- Use of untrained personnel
- Use of prohibited service products

1.4 Copyright protection

Tip for users

The information, text, drawings, pictures and other illustrations that it contains are protected by copyright and are subject to industrial property rights.
Any misuse is punishable by law.

1.5 Customer service

The MAN customer service is at your disposal for technical information.

Tip for users

For all notifications and enquiries, please specify the engine type, engine number and order number.

Information on the contact persons in charge can be retrieved whenever required via telephone, fax, e-mail or via the Internet. For the address, please see page 2.

Read the instructions carefully before starting any work!
This particularly applies to the chapter “General Safety Instructions”
and the respective safety instructions in the chapters.

2 General safety instructions

Generally applicable safety instructions and those to be observed and followed are listed, which ensure optimal protection of personnel as well as safe and fault-free operation of the engine.

Specific, handling-related or situation-related safety information is placed before the relevant handling step or the relevant description in the section concerned.

Failure to observe the handling instructions and safety information provided in this publication for service products can result in considerable danger.

2.1 Notes for people

DANGER

Risk of death from highly inflammable substances
Risk of death from highly inflammable substances, liquids and gases.

Therefore:
- Smoking is prohibited in the danger zone.
- Use of open flames or ignition sources in the danger zone is prohibited.
- Keep fire extinguisher available.
- Immediately report suspicious substances, liquids or gases to the person responsible.
- In case of fire, immediately stop work and vacate the danger zone until the all-clear is given.

DANGER

Risk of death from highly gaseous substances
Incorrect handling of the gas system leads to health impairments or death.

Therefore:
- Start-up, operation, monitoring of operating safety, servicing and maintenance of the gas system shall be carried out in accordance with the manufacturers' instructions.
- Interventions or adjustments on the gas system should be carried out by authorised specialist personnel only.

WARNING

Risk of death when handling service products

Therefore:
- Do not use any food or beverage containers for draining or storing service products or process materials.
- Observe the manufacturers' safety data sheets.

WARNING

Risk of injury from service products that are harmful to health

Therefore:
- Observe the manufacturers' safety data sheets.
- Wear personal protective equipment.
- Avoid contact with eyes and skin.
- Avoid spillage and mist formation.

WARNING

Risk of injury due to untrained personnel

Therefore:
- Allow the engine to be serviced and repaired solely by trained personnel.
- Make sure that the engine cannot be started by unauthorised persons.

2.2 Environmental protection rules

ENVIRONMENTAL NOTE

Danger of environmental pollution caused by improper handling of service products
Considerable damage is caused to the environment.

Therefore:
- Observe national safety regulations.
- Collect service products using appropriate and sufficiently large containers.
- Only store service products in original containers.
- Absorb leaked or service product with binding agent and dispose of properly.
- Inform the responsible local authority about the damage, if necessary.
- Drain cleaning liquid and rinsing water through an oil separator with a sludge trap.

ENVIRONMENTAL NOTE

Waste water must not enter into bodies of water or the ground

Therefore:
- Only carry out engine cleaning in a washing area with an oil separator.

Engine oil

Tip for users

Observe the “Handling used engine oil leaflet”!

ENVIRONMENTAL NOTE

Risk of contaminating bodies of water and soil

Therefore:
- Collect service products using appropriate and sufficiently large containers.
- Observe local legal regulations for disposal.
- Submit used oil for used oil recycling.
- Treat undiluted antifreeze as hazardous waste.

Coolant

ENVIRONMENTAL NOTE

Do not allow any service products to enter the ground or bodies of water

Therefore:
- Do not spill any service products while filling.

2.3 General information on service products

Tip for users

Observe all relevant standards, safety data sheets and national safety regulations prior to use
DIN EN 60204-1 “Electrical equipment of machinery”
MAN - data sheet “Minimum requirement of gas quality for MAN gas engines”

Tip for users

Only use service products in accordance with MAN regulations, otherwise, the liability for defects will lapse!
You can find approved products on the Internet at:
https://my.man-mn.com/portal/irj/asp

2.4 Personal protective equipment

It is necessary to wear personal protective equipment in order to minimise the risks to health while working.

- Wear the personal protective equipment that is required for the respective work at all times while working.
- Obey signs that are posted in the working area regarding personal protective equipment.

Industrial protective clothing

is tight-fitting work clothing with low tear strength, with tight-fitting sleeves and without protruding parts. They are used primarily to protect against injuries, climatic influences and dirt or contamination.

Do not wear any rings, necklaces or other jewellery on the body while working.

Hard hat

for protection against parts falling down or flying about.

Safety shoes

to protect against heavy falling parts and slipping on slippery surfaces.

Safety gloves

to protect the hands from abrasion, getting pricked or deep injuries as well as from coming into contact with hot or corrosive parts or liquids.

Wearing for special work

When doing special work, special protective equipment is necessary. Special reference is made to these in the various chapters of this manual.

Safety goggles

to protect the eyes from parts flying around and liquid sprays.

Ear protection

to protect against hearing loss caused by noise.

3 Engine oils

3.1 Important information

WARNING

Risk of injury from engine oils that are harmful to health

Therefore:
- Observe the manufacturers' safety data sheets.
- Wear personal protective equipment.
- Avoid contact with eyes and skin.
- Avoid spillage and mist formation.

NOTE

Risk of engine damage from contaminated engine oil

Therefore:
- Strict rules for cleanliness must be applied when filling the engine with engine oil.
- Remove contaminants from filler openings.

ENVIRONMENTAL NOTE

Risk of contaminating bodies of water and soil

Therefore:
- Collect engine oils using appropriate and sufficiently large containers.
- Observe local legal regulations for disposal.
- Submit used oil for used oil recycling.

3.2 Engine oils with MAN approval

For industrial gas engines, engine oils must be used that are approved according to the works standard M3271 Part 2 and Part 4.

The selection of a suitable engine oil is based on the intended oil operating time, the fuel quality used and the climatic conditions at the operation site.

The oil change intervals must basically be observed, which are specified in the Operator's Manual or the service logbook.

Tip for users

Additional information about engine oils can be found online:
https://my.man-mn.com/portal/irj/asp

3.3 Single-grade engine oils

Single-grade engine oils SAE 40 are only permitted to be used if cold starts are ruled out, i.e. only where ambient temperatures of less than +10 °C do not occur.

► Please observe the operational temperature range!

3.4 Approval requirements

The approval for engine oils is valid for **two years** and can be extended for another two years upon application by the manufacturer / supplier, provided that the quality has not changed.

Prior to every purchase, find out from your supplier whether the approval still exists by requesting submission of the MAN approval letter.

Tip for users

Only use service products in accordance with MAN regulations, otherwise, the liability for defects will lapse!
You can find approved products on the Internet at:
https://my.man-mn.com/portal/irj/asp

3.5 Engine oils without MAN approval

If no engine oils that are approved by MAN are available in certain countries, engine oils should be used, for which the manufacturer or supplier has obtained approvals from MAN.

When using these engine oils, the oil change intervals, which are specified in the Operator's Manual or the service logbook must be reduced by arrangement (consultation with MAN Truck & Bus AG, Customer Service).

The MAN customer service is at your disposal for technical information.

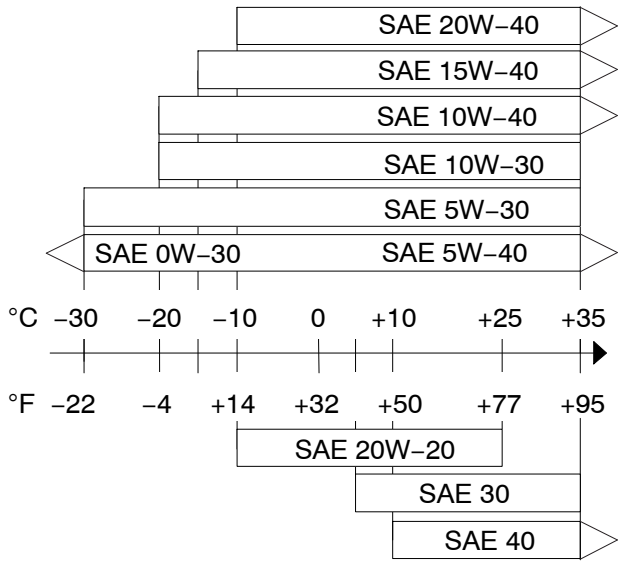
Tip for users

For all notifications and enquiries, please specify the engine type, engine number and order number.

Information on the contact persons in charge can be retrieved whenever required via telephone, fax, e-mail or via the Internet. For address, please see page 2.

3.6 SAE viscosity grades

The SAE viscosity grades must be selected according to the expected ambient temperatures (see figure).



3.7 Engine oil additives

For MAN industrial gas engines, engine oils are only approved, which have been inspected according to the works standards M3271 Part 2 and Part 4.
These oils are formulated to cope with engine requirements where the specified oil change intervals are observed.

NOTE

Risk of engine damage due to subsequently added additives to engine oil
The characteristics of the engine oil change in an incalculable manner.

Therefore:
- Do not subsequently add additives to the engine oil.
- Lapse of liability for defects.

The MAN customer service is at your disposal for technical information.

Tip for users

For all notifications and enquiries, please specify the engine type, engine number and order number.

Information on the contact persons in charge can be retrieved whenever required via telephone, fax, e-mail or via the Internet. For the address, please see page 2.

3.8 Mixing engine oils

Do not mix different engine oils together unless the performance capabilities of the oils are at least equivalent. This is to prevent deterioration in the performance of the added engine oil, which would result in a shortening of the oil change interval.

Engine oils from different manufacturers can be mixed together and are compatible with each other provided that they are intended for the same area of application.

3.9 Oil change intervals

The oil change intervals must be individually defined. For this, used oil samples must be taken after start-up of the engine at time intervals to be defined and have these analysed by the oil supplier. The time intervals shall be arranged with the oil supplier and MAN. For the address, please see page 2. On the basis of the analysis result, the permitted oil-retention time is defined and thus the oil change interval.

This approach is particularly necessary with the use of special gases, such as sewage treatment gas, landfill gas and biogas, as these gases are not uniform in terms of their main components and content of gas admixtures.

NOTE

Risk of engine damage due to gas admixtures
Gas admixtures lead to increase engine wear, corrosion or abrasive wear on pistons, liners and outlet valve seats.

Therefore:
- Observe oil change intervals.
- Limit oil-retention time.
- Assess the content of silicon compounds in combustible gas with oil analyses.
- Filter gas admixtures out of the combustible gas.

Engine oils

4 Fuel

MAN industrial gas engines can be operated with combustible gases of different origins, such as natural gas, landfill gas, sewage treatment gas and biogas.

Gaseous fuels consist primarily of methane, ethane, propane and butane, of traces of higher hydrocarbons as well as inert components such as carbon dioxide and nitrogen. Depending on the composition, the chemical-physical characteristic values of the combustible gases can differ significantly.

4.1 Important information

⚠ WARNING

Risk of injury from fuels that are harmful to health

Therefore:
- Observe the manufacturers' safety data sheets.
- Wear personal protective equipment.
- Avoid contact with eyes and skin.
- Avoid spillage and mist formation.

⚠ DANGER

Risk of death from highly inflammable substances
Risk of death from highly inflammable substances, liquids and gases.

Therefore:
- Smoking is prohibited in the danger zone.
- Use of open flames or ignition sources in the danger zone is prohibited.
- Keep fire extinguisher available.
- Immediately report suspicious substances, liquids or gases to the person responsible.
- In case of fire, immediately stop work and vacate the danger zone until the all-clear is given.

NOTE

Risk of engine damage due to gas admixtures
Gas admixtures lead to increase engine wear, corrosion or abrasive wear on pistons, liners and outlet valve seats.

Therefore:
- Observe oil change intervals.
- Limit oil-retention time.
- Assess the content of silicon compounds in combustible gas with oil analyses.
- Filter gas admixtures out of the combustible gas.

4.2 Methane number

Another important parameter of combustible gases is the methane number MZ, which characterises the knock resistance of the gas in the engine. With natural gas, the methane number should be a minimum of 80.

NOTE

Risk of engine damage from reduction of the methane number
Admixtures of liquid gas / air mixtures to natural gas lead to a reduction and shortfall of the limit value of the methane number.

Therefore:
- Do not add any liquid gas / air mixture to the natural gas.
- Obtain confirmation from the gas supply company that no admixing has been carried out.

Biogas

The methane number of biogas is significantly higher, depending on the composition, which is dependent on the fermentation substrate. The methane number can lie above 100, depending on how much carbon dioxide and nitrogen the gas is composed of. However, due to a sufficient heating value, the CO_2 content should not be above 40%.

The following table lists the minimum characteristics of the combustible gases.

Parameters	Symbol	Limit value	Unit	Comments
Methane number	MN	> 80	-	lower methane number Consultation with MAN
Thermal value	$H_{u,N}$	> 5	kWh / Nm^3	
Chlorine content	Cl	< 80	mg / Nm^3_{CH4}	Chlorine is present as volatile compound
Fluorine content	F	< 40	mg / Nm^3_{CH4}	Fluoride is present as a volatile compound
Total - Chlorine - Fluorine	∑(Cl,F)	< 80	mg / Nm^3_{CH4}	
Dust content < 5 µm		< 10	mg / Nm^3_{CH4}	
Oil vapour		< 400	mg / Nm^3_{CH4}	No condensation is permitted to occur in the mixture route.
Solvent in combustion air	VOC	< 25	mg / Nm^3_{CH4}	In case of higher concentration, consultation with MAN
Silicon content	Si	< 2	mg / Nm^3_{CH4}	In case of higher silicon concentration, consultation with MAN
Total sulphur content	S	< 200	mg / Nm^3	Hydrogen sulphide is jointly contained in the total sulphur content
Hydrogen sulphide	H_2S	< 150 / < 228	ppm / mg / Nm^3	In case of higher hydrogen sulphide concentration, consultation with MAN
Ammonia content	NH_3	< 40 / < 30	ppm / mg / Nm^3	
Relative humidity	φ	< 60	%	No condensation may occur in the mixture segment
Temperature of the gas mixture after the gas mixer	T_G	$10 < T_G < 30$	°C	

1) Silicon can be contained in the engine oil due to the addition of additives (anti-foaming agents). However, silicon can also enter into the engine oil in the form of dust due to insufficient air/gas filtering. High concentrations of silicon in the engine oil can lead to increased component wear, depending on whether silicon exists in an organic or inorganic form. With increased silicon content of the engine oil, the contents of the wear elements, iron, chromium and aluminium, also need to be assessed.

The combustible gas shall be added to the engine in the following condition:

Gas pressure on extraction [mbar]	20 ≤ p ≤ 50
max gas pressure fluctuations after zero-pressure governor [mbar]	±≤ 3
max. gas temperature [°C]	30
max. relative humidity [%]	60

It is generally recommended to conduct a gas analysis every six months.
For gas compositions that change over time, regular gas analyses and engine oil analyses are required for safe operation.

NOTE

Risk of material damage due to incorrect gas composition
Incorrect gas composition leads to exceeding the limit values.

Therefore:
- If the limit value is exceeded, shut down the engine and consult with MAN.
- Perform regular gas and engine oil analyses.

The MAN customer service is at your disposal for technical information.

Tip for users

For all notifications and enquiries, please specify the engine type, engine number and order number.

Information on the contact persons in charge can be retrieved whenever required via telephone, fax, e-mail or via the Internet. For the address, please see page 2.

Tip for users

Only use service products in accordance with MAN regulations, otherwise, the liability for defects will lapse!
You can find approved products on the Internet at:
https://my.man-mn.com/portal/irj/asp

Fuel

5 Coolant

5.1 Important information

WARNING

Risk of injury from coolants that are harmful to health

Therefore:
- Observe the manufacturers' safety data sheets.
- Wear personal protective equipment.
- Avoid contact with eyes and skin.
- Avoid spillage and mist formation.

NOTE

Risk of engine damage due to unsuitable antifreeze
Malfunction of units and components in the cooling circuit.

Therefore:
- Use suitable antifreeze.

ENVIRONMENTAL NOTE

Danger of environmental pollution caused by improper handling of service products
Considerable damage is caused to the environment.

Therefore:
- Do not spill any coolant while filling it.
- Collect overflowing coolant in a suitable container.
- Treat undiluted antifreeze as hazardous waste.

5.2 General recommendations

NOTE

Risk of material damage when the primary pressure in the cooling system is too low

Therefore:
- Keep the cooling system sealed and clean.
- Inspection of the cooling cover valves and working valves.
- Observe the required coolant level.

NOTE

Risk of engine damage due to contaminants

Therefore:
- Ensure extreme cleanliness when handling service products.
- Remove contaminants from filler openings.

Antifreezes that have been inspected and approved by us guarantee sufficient antifreeze, corrosion protection and cavitation protection, do not attack seals and hoses and do not foam.

Tip for users

Only use service products in accordance with MAN regulations, otherwise, the liability for defects will lapse!
You can find approved products on the Internet at:
https://my.man-mn.com/portal/irj/asp

The cooling systems of the engines should be filled over the entire year with a mixture of 60% water and 40% antifreeze, which guarantees cold protection up to -27 °C.

5.3 Coolant

NOTE

Risk of engine damage due to unsuitable antifreeze
Malfunction of units and components in the cooling circuit.

Therefore:
- Use suitable antifreeze.

For continuously trouble-free operation of MAN industrial gas engines, the coolant should basically be comprised of 60% water and 40% antifreeze all year round. This will guarantee sufficient corrosion protection. In special cases, the use of corrosion-inhibiting agents (chemicals) according to works standard MAN 248 is possible by arrangement.
Emulsifiable corrosion protection oils are basically not permitted.

The MAN customer service is at your disposal for technical information.

Tip for users

For all notifications and enquiries, please specify the engine type, engine number and order number.

Information on the contact persons in charge can be retrieved whenever required via telephone, fax, e-mail or via the Internet. For the address, please see page 2.

5.3.1 Prescribed components of the coolant

Water
Fresh mains water is suitable with the following restricted analysis values:
Appearance: Colourless, clear, free from mechanical contamination
Hardness: max 20° German total hardness
≙ 35.6° French hardness
≙ 25° British hardness
≙ 358 ppm USA hardness
Chlorides: max. 100 ppm
Sulphates: max. 150 ppm
pH value at 20°C: 6.5 to 8.5

You should obtain analysis values for drinking water from the relevant local authorities.
Where such mains water is not available, existing water must be mixed with fully desalinated water, or distilled water or condensation, until the foregoing analysis values are reached.

5.3.2 Checking and replacement of the coolant

NOTE

Risk of material damage due to temperature increase in the coolant
Increased antifreeze content leads to temperature increase in the coolant.

Therefore:
- Check the concentration on a quarterly basis with a density spindle or refractometer.
- Never allow the antifreeze concentration to fall below 40 Vol.-%.
- A concentration of more than 50 Vol.-% must be avoided.
- Always supplement coolant shortfalls with a mixture of water and min. 40–50 Vol.-% (-37 °C) antifreeze.
- Observer service intervals in the maintenance schedule.

► Replace all of the coolant after no later than **2 years** or after **15,000 operating hours**

► Notwithstanding these intervals, the coolant must be replaced if it discolours and becomes brown or cloudy

5.4 Antifreeze and anti-corrosion agent

Tip for users

Only use service products in accordance with MAN regulations, otherwise, the liability for defects will lapse!
You can find approved products on the Internet at:
https://my.man-mn.com/portal/irj/asp

5.4.1 Approved antifreeze according to works standard MAN 324

- The approval of a product lapses automatically **3 years** after the approval is granted.
- A change to the formulation of a product automatically ends its approval.

Tip for users

Detailed instructions for use and additional information about anti-corrosion agents and antifreezes according to standard MAN 324 can be found on the Internet at:
https://my.man-mn.com/portal/irj/asp

- Anti-freeze and anti-corrosion agents may only be used, which are approved according to works standard MAN 324. It is recommended to fill the cooling system with an anti-freeze and anti-corrosion agent according to MAN 324 Type NF.
- A minimum concentration of 40 Vol.-% must be observed.
- The cooling system is designed such that in Central Europe, coolant filling with max. 40 Vol.-% antifreeze (cold protection to -27 °C) can also remain in the summer, as long as the cooling system is functional.
- At the beginning of the cold season, the antifreeze content of the coolant should be increased in accordance with the expected ambient temperatures (see mixing table).

Mixture table:

Ambient temperature up to °C	Water %	Antifreeze %
-27	60	40
-31	55	45
-37	50	50

5.4.2 No mixing

Tip for users

Detailed instructions for use and additional information about anti-corrosion agents and antifreezes according to standard MAN 324 can be found on the Internet at:
https://my.man-mn.com/portal/irj/asp

Finished antifreeze-water mixtures with a minimum of 40 Vol.-% of an approved antifreeze in de-ionised water are permitted.

5.4.3 Anti-corrosion agent

For specific applications, where the use of antifreeze is not mandatory (e.g. in the tropics), anti-corrosion agents according to MAN 248 must be used.

5.4.4 Approved anti-corrosion agent for engine cooling systems according to works standard MAN 248

Tip for users

Only use service products in accordance with MAN regulations, otherwise, the liability for defects will lapse!
You can find approved products on the Internet at:
https://my.man-mn.com/portal/irj/asp

5.4.5 Mixing ban

► When switching from antifreeze according to MAN 324 to anti-corrosion agent according to MAN 248 or vice versa, the entire coolant should be drained out. Rinsing is not necessary.

5.4.6 Checking and replacement of the anti-corrosion agent

► Change the entire coolant after **one year** or after **1,500 operating hours**, if this is reached prior to the end of one year.

► Notwithstanding these intervals, the coolant must be replaced if it discolours and becomes brown or cloudy.

► The product-specific application concentration is shown on the Internet under the Approved Service Products.

5.4.7 Disposal of antifreeze and anti-corrosion agents

ENVIRONMENTAL NOTE

Danger of environmental pollution caused by improper handling of service products
Considerable damage is caused to the environment.

Therefore:
- Observe national safety regulations.
- Collect service products using appropriate and sufficiently large containers.
- Only store service products in original containers.
- Absorb leaked or service product with binding agent and dispose of properly.
- Inform the responsible local authority about the damage, if necessary.
- Drain cleaning liquid and rinsing water through an oil separator with a sludge trap.

ENVIRONMENTAL NOTE

Risk of contaminating bodies of water and soil

Therefore:
- Collect service products using appropriate and sufficiently large containers.
- Observe local legal regulations for disposal.
- Treat undiluted antifreeze as hazardous waste.

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