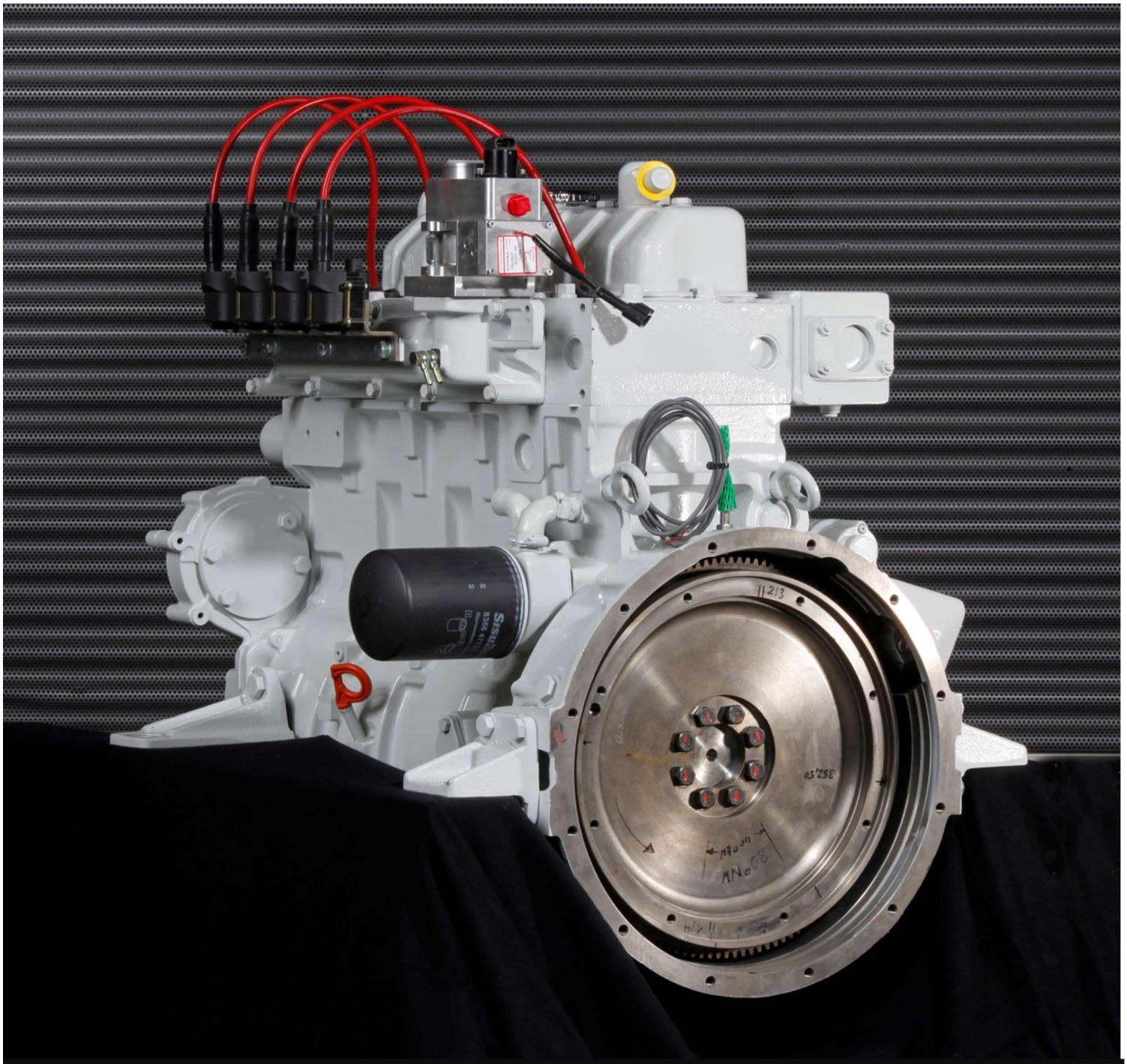
mamotec



Operating Instructions

for stationary industrial gas engines of the series
MAG 33.3-84.6

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Content

1. Preface

This manual is intended to familiarize you with the operation and maintenance of MAMotec industrial gas engines and to provide you with the basic technical data and key technical specifications. Unless otherwise specified, the manual and the values refer to all types of the motor types MAG 33.3 S xxxA, MAG 49.4 S xxxA, MAG 74.6 S xxxA and MAG 84.6 S xxxA.

In order to be able to use your motor as economically as possible, please read the operating instructions and the safety regulations carefully before starting up the motor. We reserve the right to change the setting values, equipment and maintenance and repair instructions for the engines without prior notice.

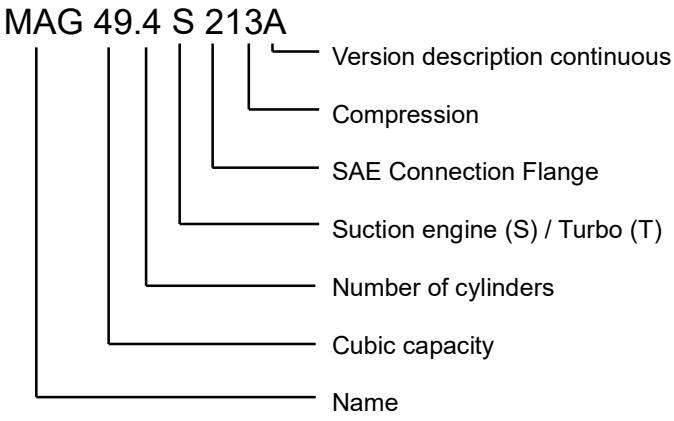
2. Safety regulations

There is always the possibility of injury during maintenance and repair work. Before starting work, read and understand the following safety instructions and information.

- Wear ear protectors when testing the engine or when working in the immediate vicinity of the engine to prevent hearing damage.
- If the engine is started in a closed room, sufficient ventilation must be provided.
- Never use aerosol-based starting aid fuels.
- Start the engine only with the starting signal of the engine control unit.
- Always switch off the engine before carrying out maintenance or repair work.
- No naked flames or smoking is permitted in the vicinity of the gas engine, gas-carrying components or starter batteries.
- If the engine is hot and the cooling water is under pressure, be careful when opening the cooling system (risk of scalding).
- Avoid touching the exhaust manifold, turbocharger and other hot engine parts.
- Secure the engine against restarting before carrying out maintenance or repair work on the gas engine.
- Keep the surface of the motor clean to avoid the risk of fire.
- At temperatures above 300°C, e.g. in the event of an engine fire, highly corrosive HF acid is released through the Viton-seals (e.g. the lowest ring seal of the cylinder liner, the ring seal of the oil pressure control valve). Do not touch the Viton seals, which have been exposed to unusually high temperatures, with bare hands. Always wear neoprene gloves or thick work gloves and safety glasses when removing these contaminants. Wash the seals and the contaminated surfaces with a 10% hydroxide or other alkaline solution. Collect the removed material in airtight plastic bags and take them to an officially approved location. ATTENTION! Under no circumstances may Viton seals be burned!
- The lubricating oil and coolant can irritate the skin if they are in prolonged contact.
- When servicing the motor, avoid oil or other liquids getting into the ground.
- Avoid unnecessary idling of the engine.
- All gaskets are asbestos-free.
- Be careful when washing the motor at high water pressure, otherwise it could easily be damaged.

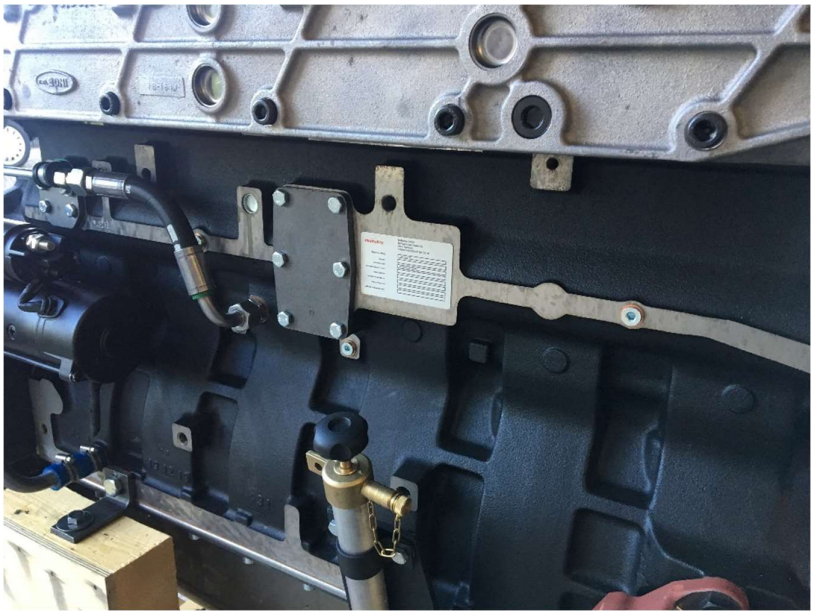
3. Motor type description

3.1. Type description



3.2. Positioning of the type plate

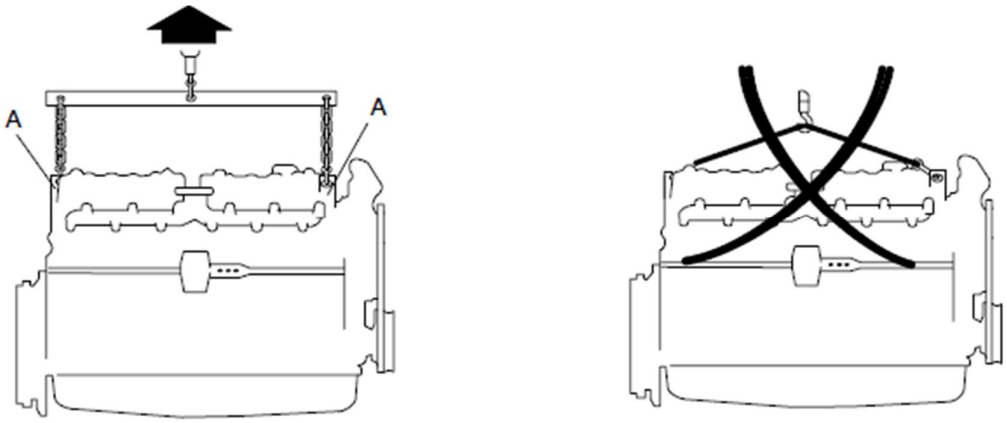
You will find the type plate on the right side of the engine frame (viewing direction opposite SAE flange) below the exhaust pipe. (see picture)



4. Anheben des Motors

⚠ DANGER

The motor can only be lifted with a lifting device where the lifting force acts vertically on the suspension eyes! Nonobservance can damage the gas engine and tear off the suspension eyes.



The special motor weights can be found in the technical data sheet of the motor.

5. Technical data

MAMotec GmbH engines are water-cooled in-line gas engines with three, four or six cylinders. The engines possess wet, replaceable cylinder liners. A possible turbocharging was already considered during the construction. In order to make the spare parts service easier and more flexible, the engines were built in a way that the same spare parts can be used regardless of the engine length.

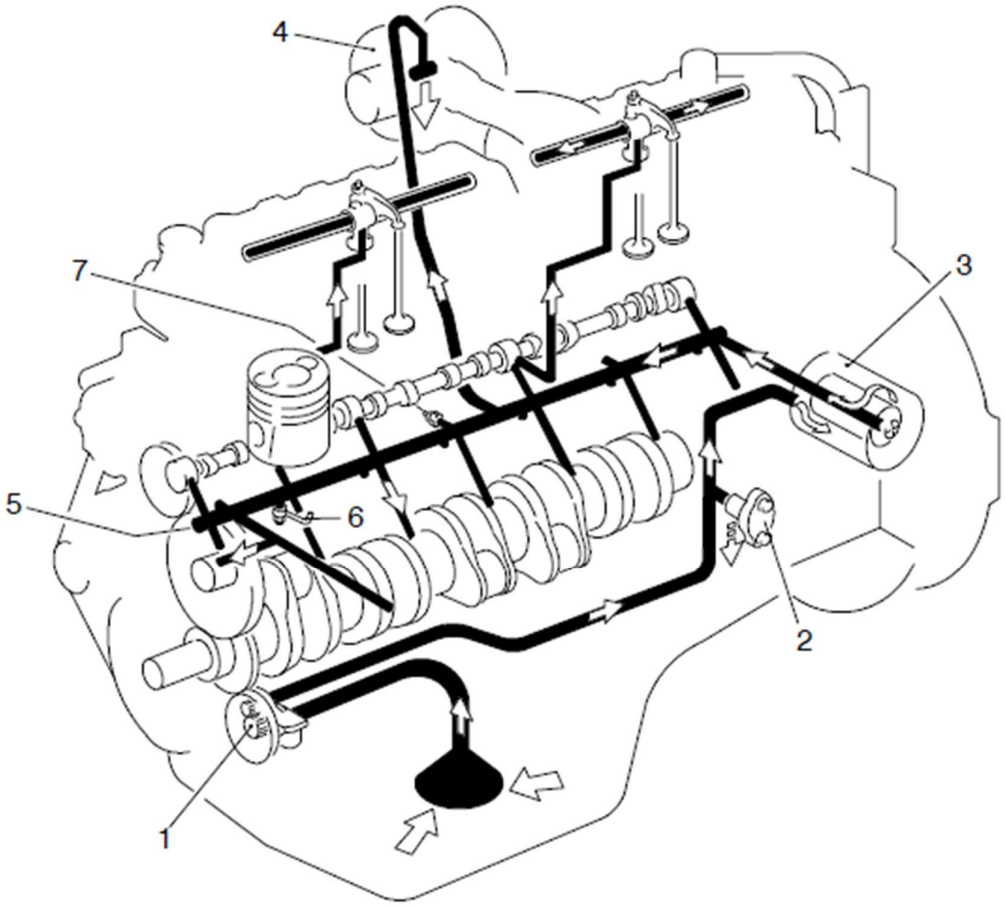
Engine Type	**MAG 33.3**	**MAG49.4**	**MAG74.6**	**MAG84.6**
Number of cylinders	3	4	6	6
Hole (mm)	108	108	108	111
Hub (mm)	120	134	134	145
Cubic capacity (Ltr.)	3,3	4,9	7,4	8,4
Combustion-procedure	Otto-Gas	Otto-Gas	Otto-Gas	Otto-Gas
Ignition sequence:	1-2-3	1-2-4-3	1-5-3-6-2-4	1-5-3-6-2-4
Compression	11/13:1	11/13:1	11/13:1	11/13:1
Ignition angle	Abhängig vom eingesetzten Brenngas			
Direction of rotation:	SAEseitig entgegen Uhrzeigersinn			
Oil pressure min (bar):	3	3	3	3
Coolant temp. max:	95°C	95°C	95°C	95°C
Coolant Spreading On/Off max.	6K	6K	6K	6K

6. Intake System

All engines are equipped with an intake manifold. When installing gas mixing systems, throttle valves and air filters, care must be taken to ensure the lowest possible pressure loss.
The components should not be mounted directly on the engine intake flange. An inlet section of 3-5x DN is recommended.

7. Lubricating oil system

The motor has a pressure oil lubrication system with the gear pump mounted at the lowest point of the motor. The oil pump is driven by the control assembly from the crankshaft. Almost all lubrication points and additional equipment are supplied with oil by the pressure oil lubrication system via holes or lines. Lubrication of the control assembly in the gear housing as well as the upper part of connecting rods and pistons is mainly carried out by immersion lubrication.
The piston crown is cooled by oil mist nozzles.

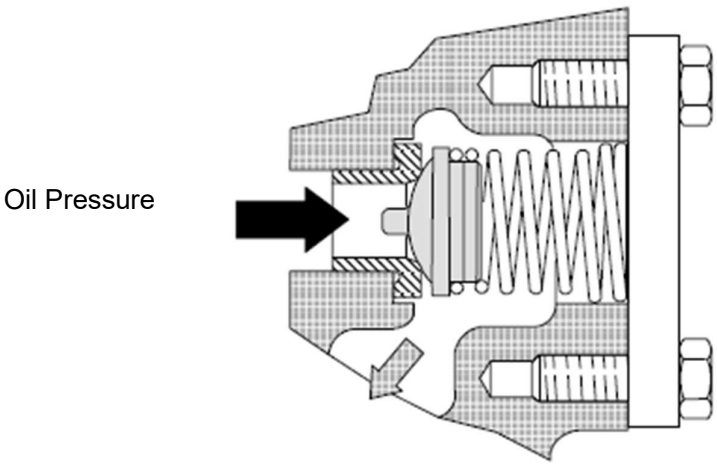


Lubrication unit

1. Oil pump
2. Oil pressure control valve
3. Oil filter
4. Turbo Charger
5. Main hole for oil
6. Piston cooling nozzle
7. Oil pressure transmitter

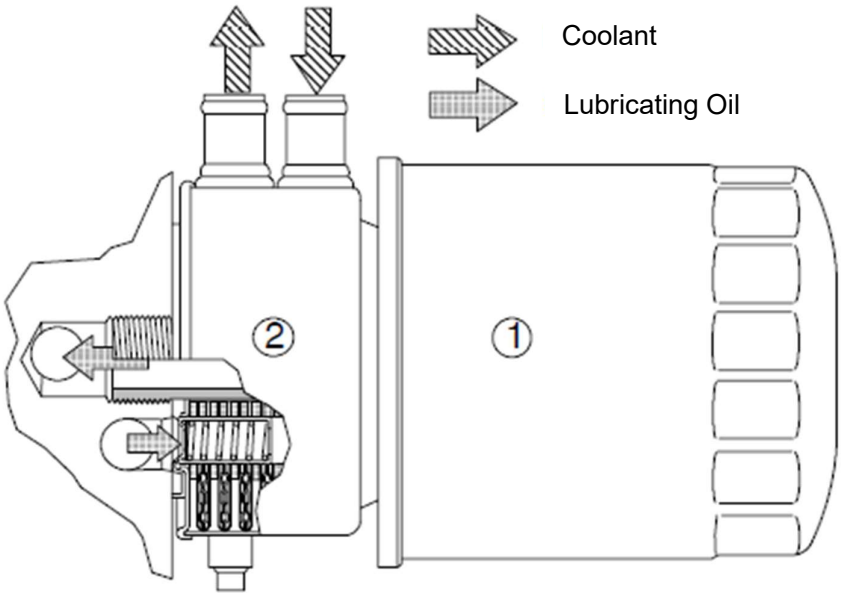
7.1. Oil pressure control valve

The oil pressure control valve is located under the oil filter on the left side of the engine. The control valve keeps the oil pressure constant regardless of the engine speed. At operating speeds, the oil pressure can vary between 3 and 4 bar, depending on the temperature and quality of the lubricating oil. At idle speed, the minimum pressure is 2.5 bar.



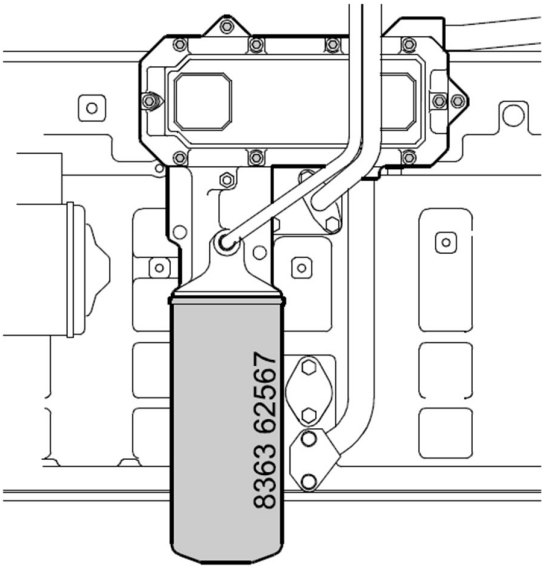
7.2. Oil filter an oil cooler

The oil filter is a one-way main flow filter, which is installed on the left side of the engine. A bypass valve located at the bottom of the filter is used to ensure a safe cold start or to ensure proper lubrication in case of filter clogging. There is also a check valve which prevents the filter from being completely drained of oil.
All engine types are equipped with an oil cooler, which is placed between the cylinder block and the oil filter. All the lubricating oil flowing through the filter also flows through the oil cooler. The lubricating oil is cooled in the oil cooler via the cooling water circulation.



1. Oil Filter
2. Oil Cooler

MAG 84.6
The oil cooler of this gas engine is a permanently installed housing on the engine block.



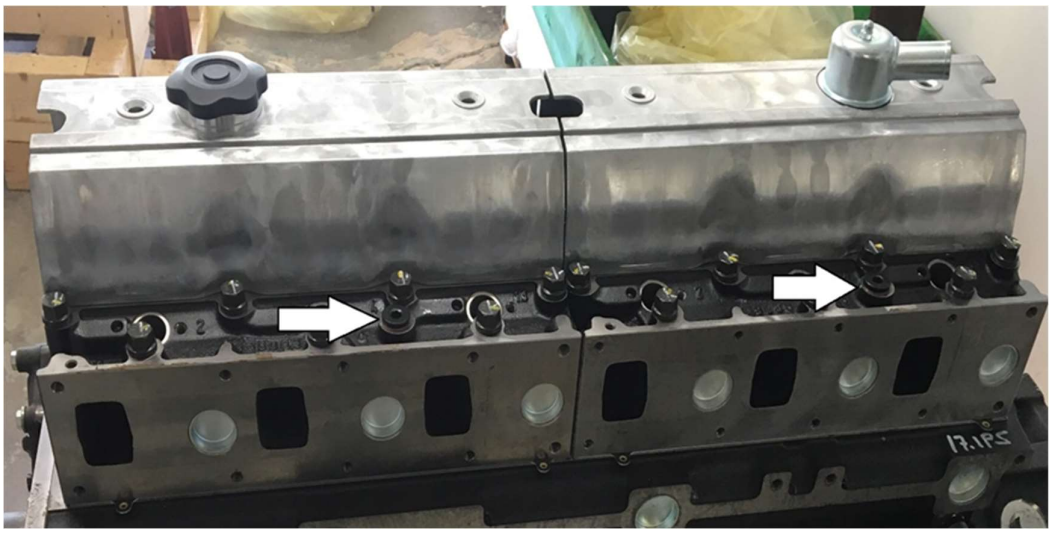
8. Cooling system

Basically the cooling system of the MAMotec industrial gas engines has to be constructed as a closed pressure system. The coolant pump has to be installed directly connected to the coolant inlet of the gas engine.
The following components must be provided in the cooling system:

- Coolant pump with flow control (differential pressure switch)
- 3-way mixing valve to control the engine inlet temperature
- Safety pressure valve
- Water shortage protection
- Diaphragm expansion tank

The cylinder head of the engine must be connected to the highest point of the cooling system with a permanently open venting pipe rising to prevent air bubbles from settling in the cylinder head.

The clear widths of the coolant pipes must at least correspond to the cross sections of the engine connections. Throttle points must be avoided.
The coolant pipe routing should be designed as aerodynamically efficient as possible. All pipes must be laid in a rising or falling manner so that no air bubbles can form.
With elastic mounting of the motor and separate arrangement of the cooling system, the pipe connections directly at the motor connection must be flexible. In the case of misaligned installation positions, the use of molded hoses is recommended, which should be as short and dimensionally stable as possible in their length, especially on the suction side of the water pump.



ATTENTION! Under no circumstances use only water as coolant, but a mixture of water and antifreeze. The requirements for the coolant can be found in the current circular.

9. Exhaust system

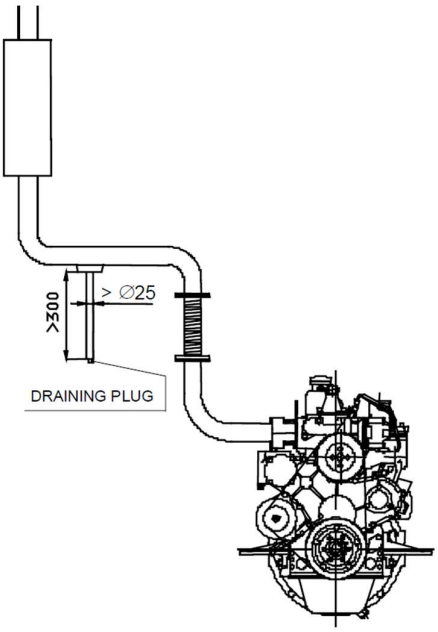
WARNING

Exhaust gases are toxic and hot.

Therefore:

- Exhaust system must be completely gas tight.
- The exhaust system must be provided with fireproof insulation.

One or more elastic intermediate pieces (compensators) must be installed between engine and exhaust system. The manufacturer's instructions must be observed during installation.



This prevents the transmission of vibrations from the engine to the exhaust system and compensates the length expansion of the exhaust pipes due to high temperatures.

The material used for the exhaust system is preferably acid-resistant steel.

The exhaust pipes heat up considerably due to the high temperature of the exhaust gas reaching several hundred degrees Celsius.

The standard value for the length expansion of steel pipes as a function of temperature is:

1 mm per meter and 100°C

In order to avoid excessive heating of the engine compartment, fireproof fuel and lubricating oil repellent insulation is recommended. The possibly dry exhaust manifold of turbo engines must be provided with a protection against contact. Insulation of these components requires a permit.

Risk of burns from hot surfaces.

WARNING

Therefore:

- Insulate exhaust pipes carefully with fireproof material!

It is not permissible to combine the exhaust gas from several engines into one system. In multi-engine systems, separate exhaust gas routing is required for each engine to prevent exhaust gas from one running engine entering the other.

Condensation water forms in the exhaust system, which may not flow into the engine under any circumstances.

In the case of very long, rising exhaust pipes, a condensate trap with a drain for the condensed water must therefore be provided near the engine. Under no circumstances may rainwater enter the exhaust system.

10. Commissioning

10.1. Inspection before starting

Check the following points before starting the engine:
- Check all gas-carrying components for damage and tightness.
- Check the oil level.
- Check the coolant level.
- Check the lubrication and cooling system for leaks.

10.2. Start

Switch on coolant pump before starting.
Switch on the starter and let it run for at least 3 seconds to ensure air flushing.
After air flushing, the ignition is released and followed by the gas line (usually automated).
After reaching the nominal speed, the system can be set under load. The load is increased from 0 to 100% over a period of 3 minutes. This minimizes the thermal load on the motor block.

Basically, a start procedure may consist of a maximum of 3 consecutive start attempts of 12 seconds each. If no speed signal is detected within 3 seconds, the start process must be stopped. The time between 2 start attempts must be at least 20 seconds. A break of 300 seconds must be observed until the next start procedure.
The number of starts must be documented in a tamper-proof manner using a start counter.

The housing temperature of the starter may not exceed 95°C during engine operation, measured at the stator on the side facing the crankcase. During the starting circuits 115°C are permitted for a short time.

WARNING

The use of aerosol-based starting aids is prohibited. This could lead to backfiring and damage to the gas engine.

10.3. Turn off

The load decrease must be reduced by a ramp control from 100% to 0% over a period of at least 3 minutes and then run after for 2 minutes without load. This minimizes the thermal load on the engine.

- Switch off release of the gas line
- Engine runs out
- Switch off ignition and control after approx. 5 seconds after engine stop.

Danger of component damage due to thermal stress

Therefore:
- The coolant pump has to run for at least 5 minutes after the engine has stopped. This minimizes the thermal load on the engine block and discharges the trapped heat.

⚠ DANGER

Risk of burns due to backfiring.

Therefore:

- The gas supply must always be switched off before ignition, so that no unburned gas residues can enter the exhaust pipe when switching off.
- In case of damage to the engine shutdown, never switch off via the ignition.
- Close main shut-off valve.
- Do not switch off the ignition before the engine has stopped.

11. Gas engine maintenance

11.1. maintenance plan

mamotec

Maintenance plan MAG 33.3 / 49.4/ 74.6/ 84.6

natural gas

	After commissioning	all	all	all	up to	up to	up to
Interval after operating hours at 1500 1/min	50	k.A.	1.500	3.000	21.000	42.000	63.000
Interval after operating hours at 1800 1/min	50	k.A.	900	1.800	13.000	26.000	39.000
maintenance interval	W1	O1*)	W2	W3	I1***)	I2***)	I3***)
Change engine oil Oil analysis *)	x	x					
Change engine oil filter *)	x	x					
Check hoses	x		x				
Perform leakage check	x		x				
Check coolant pressure			x				
Check screw connections	x		x				
Record operating data****)	x		x				
Check start sequence	x		x				
Check suction vacuum			x				
Check valve clearance, adjust if necessary			x				
Check spark plugs, replace if necessary			x				
Set/check throttle valve	x			x			
Clean/check gas filter	x			x			
Clean/check air filter	x			x			
Clean/check magnetic pickup	x			x			
Check coolant concentration	x			x			
Check ignition timing	x			x			
Measuring crankcase pressure	x			x			
Measure exhaust back pressure including catalytic conver	x			x			
Checking emissions and lambda	x			x			
Check exhaust system for external contamination	x						
Change spark plugs	x			x			
Check compression pressure				x			
Check/change oil separator				x			
Check/calibrate sensors				x			
Check screw connections				x			
Renew coolant					x		
Measuring crankshaft axial play					x		
Check/replace cylinder heads					x		
Check liners					x		
Replace liners						x	
Check/replace connecting rods						x	
Check/replace connecting rod bearing						x	
Replace piston rings						x	
Check/replace piston						x	
Engine overhaul							x

*) The intervals between engine oil changes are determined by regular oil analyses depending on the operating conditions and the engine oil used and in strict compliance with the limit values for used oil of MAMotec GmbH.

**) For repairs I1, I2, I3, the intervals are forecast and non-binding, taking into account the minimum requirements in each case. the gas quality for MAMotec industrial gas engines and operation of the engines according to TA-Luft exhaust gas limits

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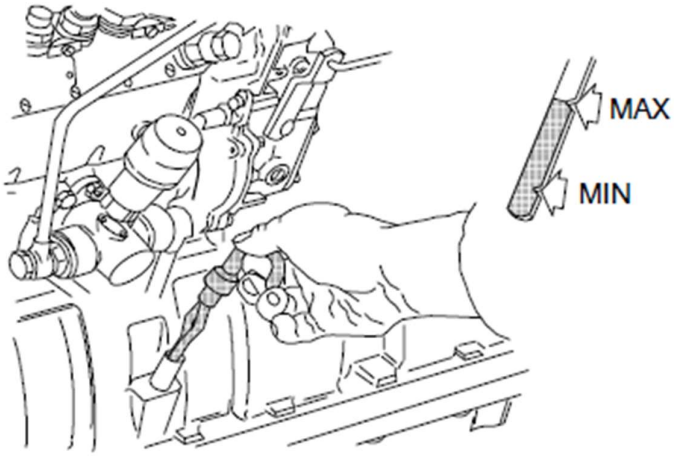
11.2. Daily check

11.2.1. Check oil level

Check the motor for leaks by visual inspection.
Switch off the engine and wait a few minutes before checking. The oil level should be in the area between the two markings on the dipstick. When adding oil, always refill to the upper mark.



11.2.2. Check coolant level

Check the motor for leaks by visual inspection. The coolant pressure should be at least 0.5 bar before entering the engine, otherwise there is a risk of component cavitation.
Check the anti-freeze content of the coolant before the cold season begins.

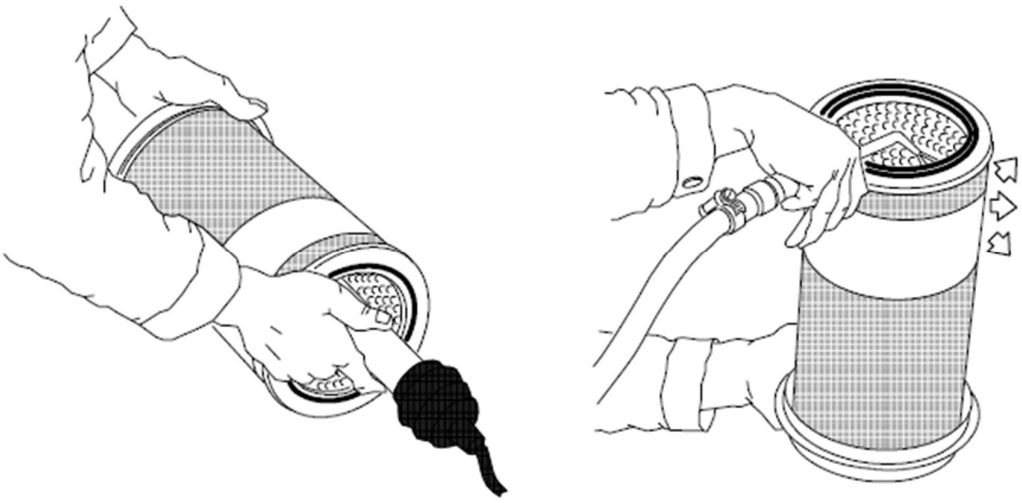
⚠ DANGER

Never use only water as coolant! If cold coolant is poured into the engine, it can be damaged!

11.3. Regular maintenance

11.3.1. Clean / change air filter

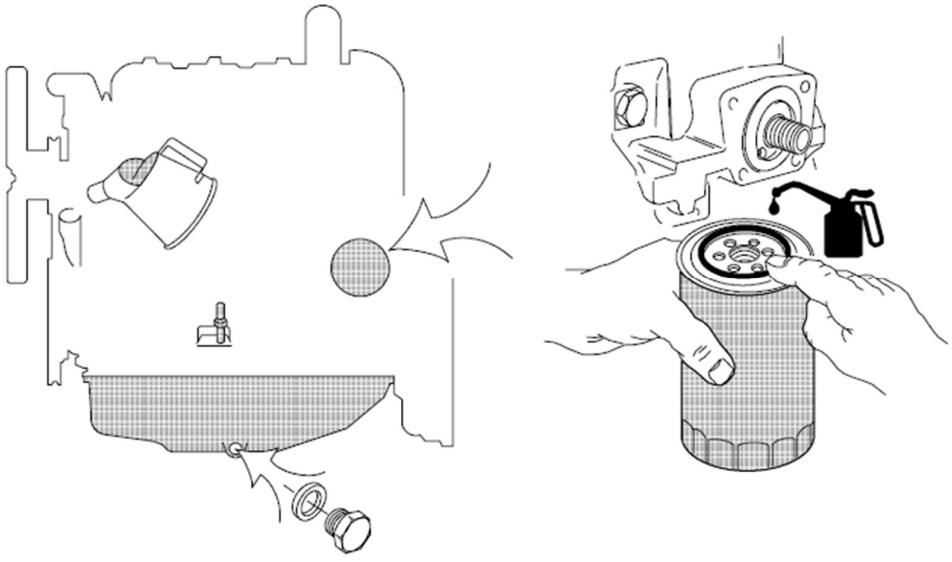
Always switch off the motor before cleaning or replacing.
Loosen the nut on the bottom of the air filter respectively loosen the clamps and remove the filter insert.



Clean the filter insert with compressed air at a maximum pressure of 5 bar. Hold the compressed air gun at an angle on the filter and move it from the center of the filter to the outside. Hold the filter against the light or insert a light source into the filter and check for holes or cracks. If the filter is damaged, it must be replaced. When reattaching the filter insert, make sure that it is properly seated, that the seals are in good condition and that the seals are clean. Do not overtighten the nut on the bottom of the air filter.

Some motors have an electrical or mechanical indicator on the air supply line to show when the filter needs cleaning. With the electrical indicator, a warning is shown on the control system to indicate the need for maintenance. In case of mechanical indicator, the filter must be cleaned or replaced when the indicator is red. The display can be reset by pressing the button on the vacuum indicator.

11.3.2. Change lubricating oil



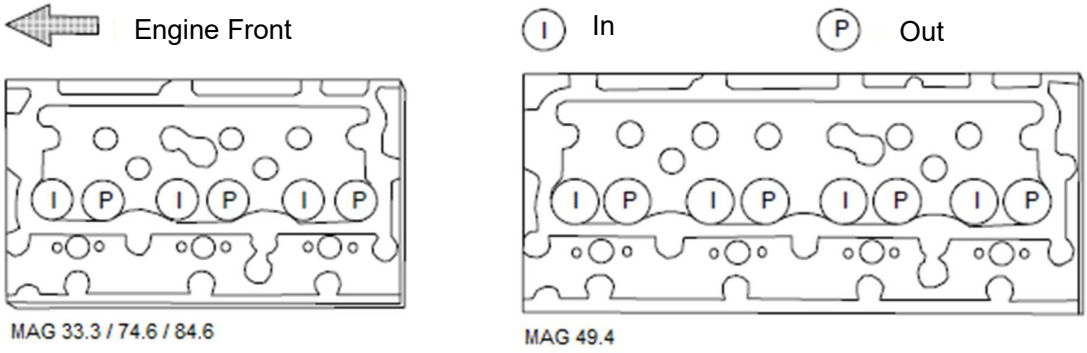
Run the engine warm. Loosen the oil drain plug and drain the oil into a suitable container. When the oil pan is empty, retighten the drain plug. Use a new sealing ring each time the drain plug has been loosened.
If the engine is equipped with an oil drain pump, use this pump to empty the oil pan.
Pour new oil through the filling opening up to the prescribed oil level (upper marking line on the dipstick). Note the capacity of the oil filter (approx. 0.7 ltr). For further information on approved engine oils and oil limit values, please refer to the valid circular.

11.3.3. Change oil filter

Clean the surrounding components before removing the oil filter. Use an oil filter wrench or oil filter sling to unscrew the old filter. Lightly oil the rubber seal of the new filter and clean the sealing surfaces. Screw the new filter in by hand. Wipe off any oil that may have run down the chassis. Start the engine. Make sure that no oil leaks from the filter.
The engine warranty is only valid if original oil filters are used.

11.3.4. Adjust valve clearance

The nominal dimension for the valve clearance is 0.5mm for inlet and exhaust valve. The valve clearances can be checked when the engine is hot or cold. To adjust the valve clearance, the piston of the respective cylinder is turned to the top dead point.



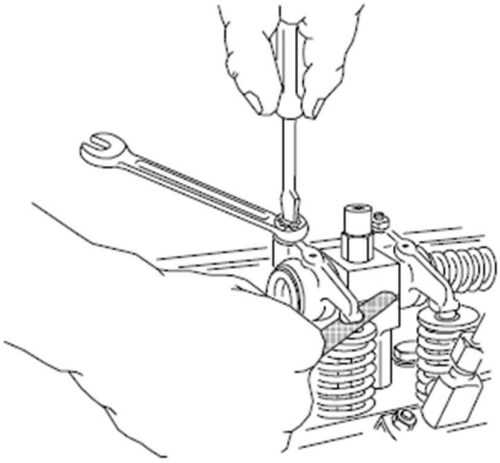
MAG 33.3
Check the valve clearance of each valve in the firing order;
in this case 1-2-3.
To adjust the valves of the first cylinder, the exhaust valve (6th valve seen from the front of the engine) of the third cylinder must be fully open.
To adjust the valves of the second cylinder, the outlet valve of the first cylinder (2nd valve) must be fully open.
To adjust the valves of the third cylinder, the exhaust valve of the second cylinder (4th valve) must be fully open.

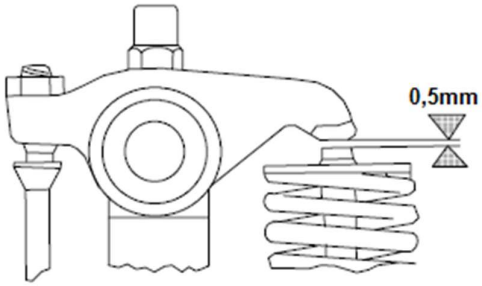
MAG 49.4
Turn the crankshaft in running direction until the valves of the 4th cylinder move (i.e. the exhaust valve closes and the intake valve opens) and adjust the valve clearance at the first cylinder.
Turn the crankshaft half a turn in running direction until the valves of the 4th cylinder move and adjust the valve clearance at the 4th cylinder.
Check the valve clearance of the individual valves in the firing order:

Firing order:	1-2-4-3
Crossover clock:	4-3-1-2

MAG 74.6 / 84.6
Turn the crankshaft in running direction until the valves of the 6th cylinder move (i.e. the exhaust valve closes and the intake valve opens) and adjust the valve clearance on the first cylinder. Turn the crankshaft a third turn in running direction until the valves of the 2nd cylinder move and adjust the valve clearance at the fifth cylinder.

Firing order:	1-5-3-6-2-4
Crossover clock:	6-2-4-1-5-3

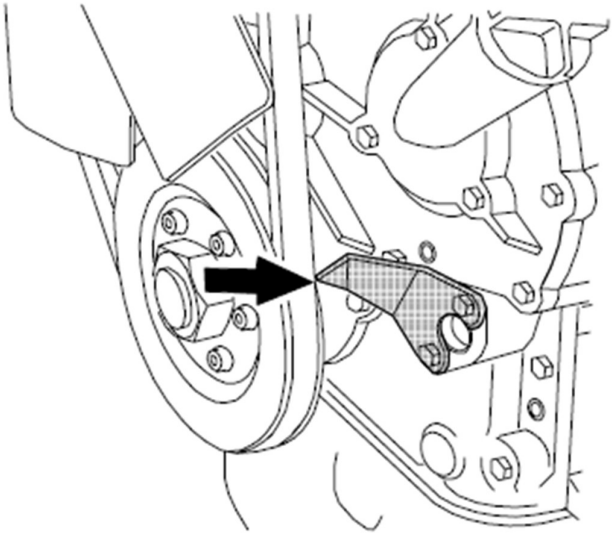




- Loosen the lock nut of the adjusting screw on the rocker arm.
- Check the valve clearance with a feeler gauge and correct the valve clearance by turning the adjusting screw.
- Tighten the lock nut and check again that the valve clearance is correctly adjusted.

11.3.5. Check ignition timing

Let the engine run at idle or at the load point to be tested. Connect a stroboscopic lamp to the first cylinder and hold the stroboscopic lamp to the pointer of the pulley. The ignition angle visible at the moment of flash corresponds to the ignition point before top dead center.



12. Shutting down the motor

When storing the new motor as well as after taking the motor out of operation, the preservation regulations must be observed. These can be found in the technical circulars.