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This Circular supersedes:
2105/17

Specification for Lubricating Oil

Valid for: **MWM Gas Engines**

The 18th replacement is made on account of:

- Limit values
  - Test method i pH value added
- Introduction of new lubricating oils
- Updating the released lubricating oils

Contents:

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Note:
The part numbers stated in this documentation are not subject to the modification service.
For identifying spare parts, the spare part documentation has to be referred to.

Copies to:
- TR
- According to SIT 7010

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General information

Risk of destruction of components

From non-approved lubricating oils

- Only use released lubricating oils

The owner is solely responsible for observing the lubricating oil specification described.

The operator must be able to demonstrate his maintenance obligation by analyzing the lubricating oils in accordance with this lubricating oil specification.

The manufacturer accepts no liability for damage caused by the use of non-approved lubricating oils or by improper operation.

Lubricating oils for combustion engines are exposed to extreme mechanical and thermal stress. The lubricating oil should not evaporate at the high temperatures of the cylinder liners but should form a sufficiently tenacious, pressure-stable, well adhesive lubricating film. It should be thin enough in the cold state to enable starting of the cold engine. The sliding surfaces of the engine components should remain wet for restarting the engine when the engine is shut down.

The lubricating oils must generally have the following properties:

- stable lubricating film at all operating temperatures
- optimal viscosity at all operating temperatures
- high thermal stability
- high resistance to aging
- wear-preventing properties
- neutralizing properties against corrosive materials
- balanced ratio of ash-forming active ingredients
- high safety reserves for long lubricating oil change intervals

Economic operation is achieved by as long a lubricating oil change interval of the lubricating oil filling as possible. The emphasis is always on the avoidance of damage and achievement of the expected service lives of important engine components.

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Lubricating oil selection

Lubricating oils (sulfate ash content up to 0.6 wt. %)

The lubricating oils listed in the section **Approved lubricating oils (sulfate ash content up to 0.6 wt. %)** must be used for operating gas engines.

Lubricating oils (sulfate ash content 0.6 - 1.0 wt. %)

Other lubricating oils are approved specially for operation with combustion gases with a higher pollution load (see also Technical Bulletin (TR) 3017). These are listed in the section **Approved lubricating oils (sulfate ash content 0.6 - 1.0 wt. %)**.

These lubricating oils are recognizable according to the manufacturer's data sheet by their high TBN and sulfate ash values and have a higher neutralization reserve against acids which are produced by the burning of pollutants in the combustive gas. These acids are produced, for example, from chlorine (Cl), fluoride (F) and sulfur (S). The neutralization of the acids protects the engine from corrosion.

Larger amounts of lubricating oil additives are necessary to ensure neutralization. However, this means the higher the neutralization potential of a lubricating oil, the higher the tendency for deposits to form during combustion.

If such lubricating oils are used in combustive gases which exhibit no continuously high pollutant loads (in accordance with the values permitted in the Technical Bulletin (TR) 3017), the additives are not consumed because no or only small amounts of acids are produced which have to be neutralized.

Here, the advantages of these special lubricating oils become clear disadvantages.

- The unused additives form deposits in the combustion chamber and in the following system parts such as exhaust gas heat exchanger, silencer etc.
- These deposits can bond with elements in the combustive gas, e.g. silicon (Si), in the combustion chamber. These compounds are very hard and lead to abrasive wear on pistons, piston rings, cylinder liners, valves and valve seat rings.

We therefore recommend that you operate all engines with lubricating oils according to section **Approved lubricating oils (sulfate ash content up to 0.6%)** until a stable combustive gas generation has been achieved. During this time, the boundary conditions and effects of the used combustive gas on economical and reliable operation of the engine must be determined by lubricating oil and gas analyses.

If, at the end of the system start-up process, the concentration of pollutants in the combustive gas remains continuously high and no economical lubricating oil change intervals are reached as a result, you can convert to lubricating oils in accordance with section **Approved lubricating oils (sulfate ash content 0.6 - 1.0 wt. %)** in agreement with the service partner responsible.

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Lubricating oil sampling

A careful preparation and execution of the the lubricating oil sampling is a prerequisite for useful analysis values.

Make sure that the lubricating oil sample is not falsified by dirt or residue lubricating oil in the additives.

About 100 ml of lubricating oil is sufficient for a routine analysis.

The lubricating oil sample must be taken from the lubricating oil circuit whilst the engine is running and warm.

For further information on the lubricating oil sampling, see

- Genset Operating Manual ⇒ Job Cards
  - B 8-1-1 Sampling the lubricating oil

At least 100 ml of lubricating oil must be drained and properly disposed of before taking the sample. Then the necessary amount of lubricating oil for the lubricating oil sample must be taken.

Changes in the lubricating oil due to sampling and transport are to be avoided.

The samples must be clearly identified and the following minimum information contained:

- Operator
- Engine type
- Engine serial number
- Manufacturer of the lubricating oil
- Designation of the lubricating oil
- Date of the sampling
- Operating hours of the engine
- Operating hours of the lubricating oil
- Filling amount / lubricating oil consumption
- Total lubricating oil volume

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Lubricating oil analysis

The operator must guarantee that the analysis values necessary for choosing the lubricating oil change intervals are available on schedule.

The analysis values must be presented to the operator as quickly as possible (maximum half of the lubricating oil analysis interval).

Perform the first lubricating oil analysis independently of the combustion gas type after 100 operating hours.

A detailed lubricating oil analysis must ensure that the engine is operated with lubricating oil according to the specification in this technical bulletin. Lubricating oil analysis reports must be kept to provide proof of this proper operation of the engine.

In case of abnormal wear values within an analysis series, the analysis must be submitted to the service partner responsible for engines still under guarantee.

The trend analysis is most suitable for monitoring the analysis values over a longer period of time. The individual analysis values are recorded here in tables or graphs. This allows an assessment of the condition of the lubricating oil and the engine (trend detection).

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Lubricating oil change

Lubricating oil change

The entire amount of lubricating oil must be replaced when performing a lubricating oil change. The remaining lubricating oil volume in the engine and add-on parts should be kept as low as possible.

The lubricating oil change is necessary when one of the following criteria is satisfied:

- upon approximation to the permissible limit value
- after penetration of the lubricating oil system by coolant
- after maintenance work of the maintenance and service schedule E60 and E70
- after service work of a scope E60 or E70
- at least once a year
  - This does not include gensets with a lubricating oil change interval as per lubricating oil analysis greater than 10000 oh.

Lubricating oil change intervals

In addition to the lubricating oil quality, the lubricating oil change intervals are dependent on:

- the combustion gas quality
- the ambient conditions
- the operating principle of the engine

As a rule, these influences lead to a change in the lubricating oil parameters.

It is therefore necessary to determine the lubricating oil change intervals by lubricating oil analyses for every system.

By suitable choice of the time intervals for the lubricating oil analyses, the lubricating oil can be used until reaching the limit values.

The lubricating oil change intervals must always be re-determined when:

- commissioning the system
- changing the type of operation
- after maintenance work of the maintenance and service schedule E60 and E70
- after service work of a scope E60 or E70

Under unchanged operating conditions, the further lubricating oil analysis intervals and the necessary lubricating oil change must be agreed between the operator and the responsible service partner on the basis of this technical bulletin.

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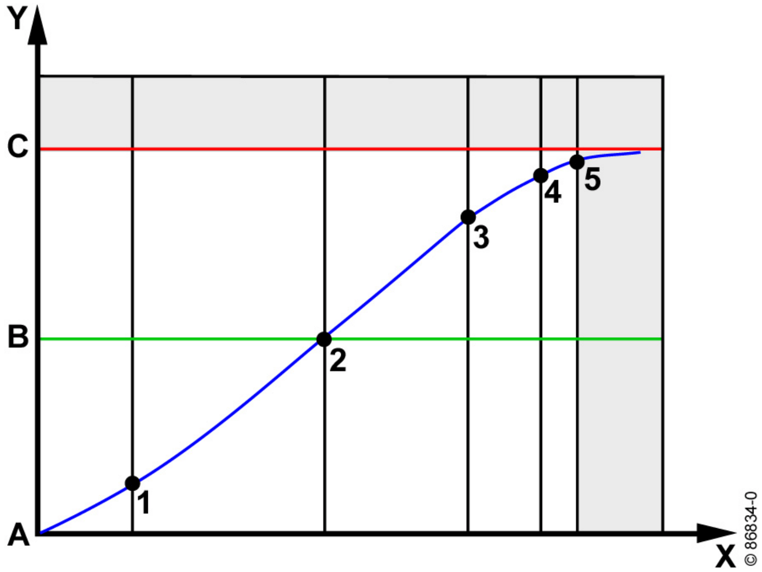
The lubricating oil change intervals must be determined as follows:

Example 1:



A 1

X axis:	Time period
Y axis:	Numeric value of the analysis result
A:	Initial value
B:	Half of limit value
C:	Limit value
Position 1-5:	Time of the lubricating oil analysis
Position 5:	Time of the next lubricating oil change

- First lubricating oil filling
  - If the analysis values (position 1) are well below half the permissible limit values B, the timer interval before the next lubricating oil analysis (position 2) can be doubled.
  - If individual analysis values reach half the permissible limit value B, the time interval before the next analysis (position 3) must be reduced.

On approaching the permitted limit value C, the time intervals from analysis to analysis (position 4 and 5) must be halved respectively.

- Second and further lubricating oil fillings
  - After the first determination of the lubricating oil change interval, the first lubricating oil analysis can be taken after a greater interval (position 3) for the second lubricating oil filling.

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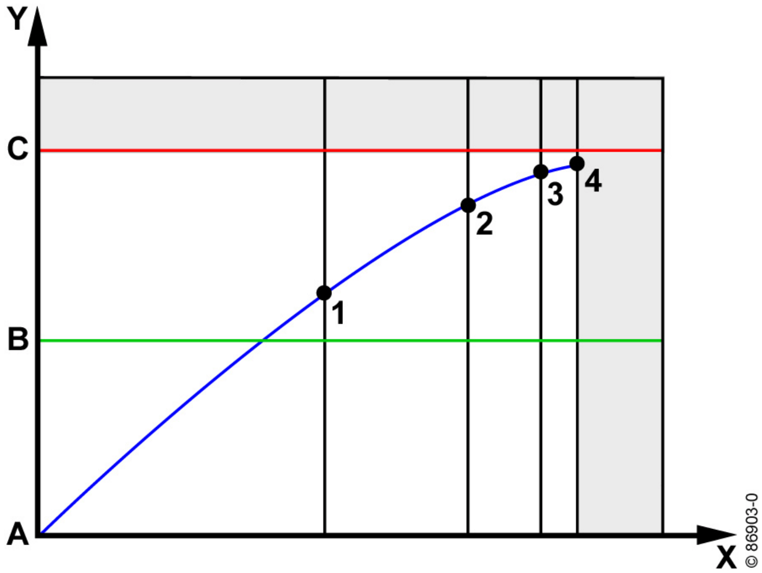
- Another lubricating oil analysis (position 4) is taken if comparable analysis results with the first lubricating oil filling are obtained.
- If, on the other hand, the same analysis values are reached, the same lubricating oil change interval as in the first lubricating oil filling can be determined.
- In case of unchanged operating conditions, the lubricating oil analyses for the following lubricating oil fillings can be taken at the same interval (position 4).

If the analysis results deviate from the previous results, the lubricating oil change intervals must be re-determined until repeatable results are achieved.

Example 2:



A 2

X axis:	Time period
Y axis:	Numeric value of the analysis result
A:	Initial value
B:	Half of limit value
C:	Limit value
Position 1-4:	Time of the lubricating oil analysis
Position 4:	Time of the next lubricating oil change

- If the analysis values of the first lubricating oil sample are already close to the permitted limit values (position 1), the operating time until the next lubricating oil analysis must be reduced (position 2).
- If the short distance from the limit values is confirmed, the last analysis period (position 3 to 4) must be halved.

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Lubricating oil change intervals for series TCG 2016 without increased lubricating oil volume

Owing to the time delay between the lubricating oil sampling and availability of the analysis results (resulting from the mail service and processing time), the procedure described above can only be applied to a limited extent for engines of the TCG 2016 series without increased lubricating oil volume.

To prevent limit values from being exceeded in all cases during the analysis period, the following procedure must be applied:

- After 100 oh
  - First lubricating oil sample
- At 250 oh
  - Second lubricating oil sample, then renew lubricating oil

Depending on the results of the lubricating oil sampling, the change time can now be gradually increased by 50 operating hours, if the limit values have not yet been exceeded by the change time.

Analogous to this, the change interval must be reduced if the limit values are exceeded.

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Lubricating oil filter change

All lubricating oil filters must always be replaced when performing a lubricating oil filter change.

The lubricating oil filter change is necessary:

- after 4000 operating hours at the latest - unless otherwise indicated in the maintenance plan
- with the first lubricating oil change after commissioning
- with the first lubricating oil change after maintenance work of maintenance level E60 and E70, or after repair work of a scope E60 or E70
- at least once a year
- if a SAN has been detected in the lubricating oil - see limit values
- after penetration of the lubricating oil system by coolant

After coolant has entered the lubricating oil system, all filter elements in the crankcase breather and the sub-stream lubricating oil filter (TCG2032) must be replaced.

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Limit values

Risk of destruction of components

Due to failure to comply with the limit values

- If one of the following limit values is not complied with, the lubricating oil must be changed immediately.

During operation

Properties	Limit value	Test method
Viscosity at 100 °C	min. 12 mm^2/s (cSt) max. 18 mm^2/s (cSt)	DIN 51366, ASTM D 445, DIN EN ISO 3104
Increase in viscosity in comparison with the new condition at 100 °C	max. 3 mm^2/s (cSt)	
Water content	max. 0.2 %	DIN 51777, ASTM D 1744, DIN ISO 12937
Glycol content	max. 500 ppm	DIN 51375, ASTM D 4291
Total base number TBN	min. 2.0 mg KOH/g	ISO 3771, ASTM D 4739
ON	not greater than the TBN	DIN EN 12634, ASTM 664
SAN[1)]	max. 0.2 mg KOH/g	ASTM 664
i pH value	min. 4.5	ASTM D 4976
Oxidation[2)]	max. 20 A/cm	DIN 51453
Nitration	max. 20 A/cm	DIN 51453
Silicon	max. 300 mg/kg	DIN 51396, ASTM D 5185

[1)] The SAN must only be determined for Low gas quality combustion gases.

[2)] Determining the oxidation for lubricating oils that contain synthetic esters does not apply.

If a wear metal exceeds its permissible limit value, then the limit value for silicon decreases to max. 15 mg/kg (DIN 51396, ASTM D 5185)

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During decommissioning

When decommissioning, the acidity of the lubricating oil can cause non-usage damage to parts carrying lubricating oil. The acidity is characterized by the alkaline reserve (TBN, Total Base Number) and the pH value.

To avoid damage during non-use, the following limit values must not be fallen below.

Properties	Limit value	Test method
Total base number TBN	min. 3.5 mg KOH/g	ISO 3771, ASTM D 4739
i pH value	min. 5.0	ASTM D 4976

If the analysis values are above the values indicated, the lubricating oil can remain in the genset during the shutdown phase and be used when putting into operation again.

If measured values from the lubricating oil analysis fall below the limit values indicated above, the lubricating oil must be replaced.

Then operate the genset for at least 12 hours.

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Wear metals

The wear metals data provides an aid for engine assessment. In this way, changes in the engine conditions can be detected at an early stage.

For analysis, the temporal concentration progression of every individual wear metal must be monitored in several lubricating oil analyses (trend analyses).

The wear rate of every individual value, and not its absolute value, is the decisive factor here.

If a wear metal exceeds 50% of the analysis value listed below, the time intervals for the sampling must be halved.

If the increased wear values are confirmed, the responsible service partner must be consulted.

All measurements must be made according to DIN 51396 (ICP OES / RFA).

Example:

Calculate wear rates

$$\mathbf{v_v = (c_1 - c_2) / (t_1 - t_2)}$$

v_v = wear rate

c_1 = new concentration

c_2 = old concentration

t_1 = new operating hours

t_2 = old operating hours

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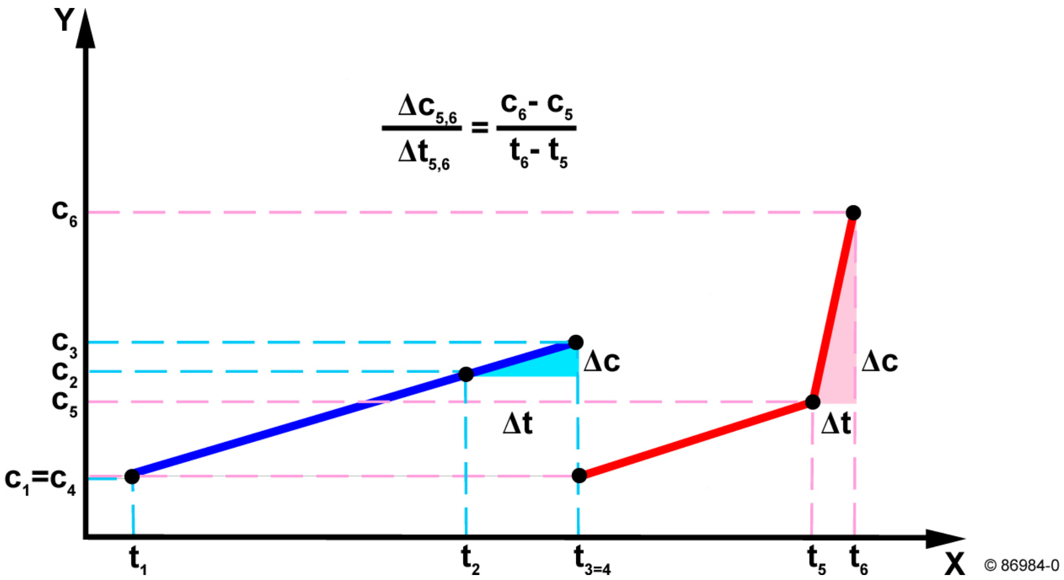
Six lubricating oil samples were analyzed for an engine. Lubricating oil was changed after the 3rd lubricating oil analysis $t_{3=4}$. From the penultimate lubricating oil analysis t_5 to the last t_6, the wear metal concentration c_6 increases considerably faster than expected from earlier lubricating oil analyses.

Since the last rate of increase (delta $c_{5.6}$ / delta $t_{5.6}$) is above 50% of the limit value, the time interval up to the next lubricating oil analysis must be halved.



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X axis:	Time period
Y axis:	Numeric value of the analysis result
$t_{3=4}$	Time of changing the lubricating oil
$c_1=c_4$	Concentration in the new lubricating oil

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Limit values for wear rate

Model series 616 / 2016	
Aluminum	max. 1 mg/kg per 100 oh
Chrome	max. 0.5 mg/kg per 100 oh
Copper	max. 2.5 mg/kg per 100 oh
Iron	max. 3 mg/kg per 100 oh
Lead	max. 2 mg/kg per 100 oh
Tin	max. 1 mg/kg per 100 oh
Model series 620 / 2020	
Aluminum	max. 1 mg/kg per 100 oh
Chrome	max. 0.5 mg/kg per 100 oh
Copper	max. 1.5 mg/kg per 100 oh
Iron	max. 2 mg/kg per 100 oh
Lead	max. 2 mg/kg per 100 oh
Tin	max. 0.5 mg/kg per 100 oh
Model series 632 / 2032	
Aluminum	max. 0.5 mg/kg per 100 oh
Chrome	max. 0.5 mg/kg per 100 oh
Copper	max. 1 mg/kg per 100 oh
Iron	max. 2 mg/kg per 100 oh
Lead	max. 1 mg/kg per 100 oh
Tin	max. 0.5 mg/kg per 100 oh

Conversion table		
1 mg/kg	1 ppm	0.0001 %
10 mg/kg	10 ppm	0.001 %
100 mg/kg	100 ppm	0.01 %
1000 mg/kg	1000 ppm	0.1 %
10000 mg/kg	10000 ppm	1.0 %

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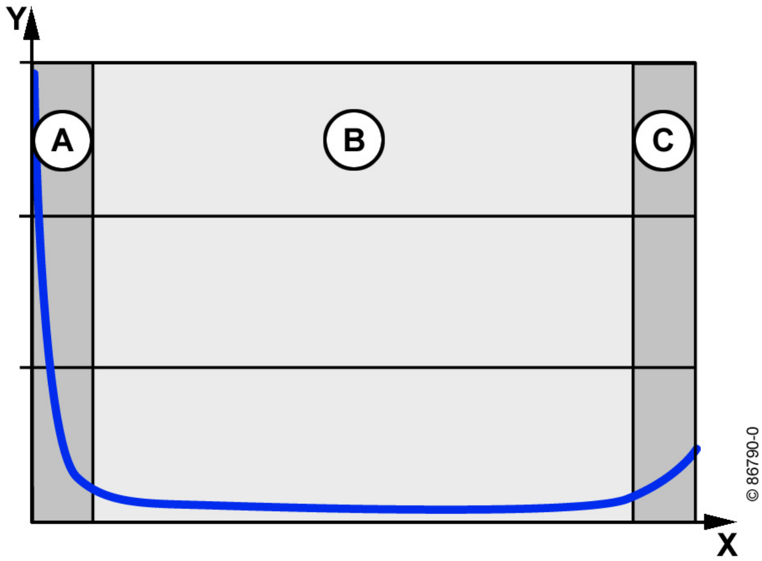
Lubricating oil consumption

The specific lubricating oil consumption is to be understood as the lubricating oil volume which is consumed per unit of time at a definite power.

The lubricating oil consumption is determined over a longer period in the same type of operation in continuous operation.

The lubricating oil consumption drops after the first few operating hours (run-in time). Then it should remain constantly low for a longer period. The wear in the engine increases with a very long running time and with it the lubricating oil consumption.



A 4

X axis:	Period
Y axis:	Lubricating oil consumption
Range A:	Run-in time
Range B:	Operating period
Range C:	Period of rising lubricating oil consumption due to increasing material wear

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Interpretation of parameters of the lubricating oil analysis

Viscosity

Unit: mm^2/s

The viscosity indicates the flow capacity of the lubricating oil (resistance to shift of two adjacent layers, inner friction). The viscosity is temperature-dependent.

The viscosity is increased by:

- Ageing/oxidation
- Soot/solid foreign bodies
- Evaporation of lightly boiling components

Total Base Number (TBN)

Unit: mgKOH/g

The TBN indicates the alkaline reserve of the lubricating oil and characterizes the chemical neutralization capacity.

This is a necessary property of the lubricating oil to check the corrosive wear.

With the use of the lubricating oil, the alkaline reserve is reduced by reaction with acids. The acids are ultimately reaction products of the combustion process as well as ageing/oil oxidation and nitration.

In operation with acid forming combustive gases (especially landfill, sewage and bio-gases), a fast decomposition of the TBN is to be expected.

Acid Number (AN, formerly TAN) or Neutralization Number (Nz)

Unit: mgKOH/g

The method covers the strong and weak acids. The strong acids are recorded separately as Strong Acid Number (SAN). Lubricating oil ingredients influence the value of the AN which may be between 0.5 and 2 mgKOH/g in new lubricating oils.

Oxidation and nitration processes can produce weak organic acids. These are only partially neutralized by the alkaline properties of the lubricating oil. If the lubricating oil has a sufficient alkaline reserve, the AN only records the weak organic acids.

There is a rough correlation between AN rise, lubricating oil ageing and lubricating oil nitration.

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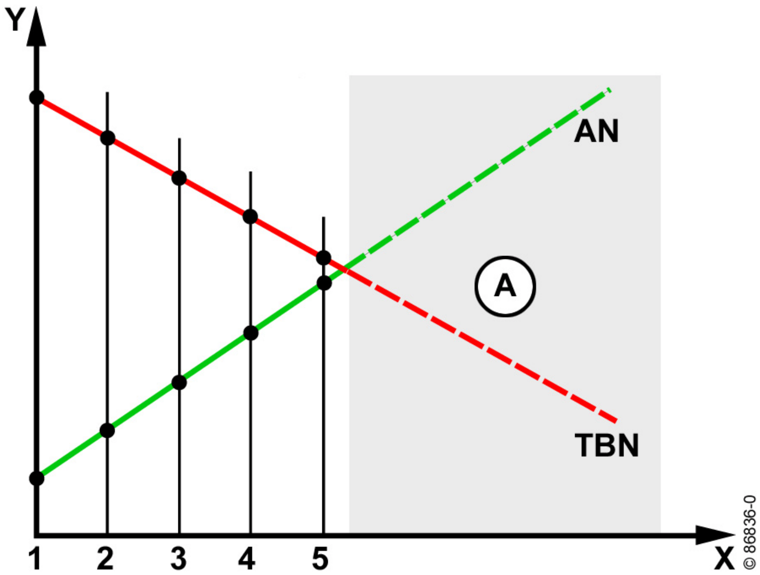
Explanation of the relation between TBN and AN.

The TBN falls whilst the AN rises. Since, according to the limit value list, the AN must always be smaller than the TBN, no engine operation is permitted in range A.



A 5

X axis:	Period
Y axis:	Numeric value of the analysis result
Range A:	non-permitted operating period
Position 1-5:	Time of the lubricating oil analysis
Position 5:	Time of the next lubricating oil change

Strong Acid Number (SAN)

Unit: mgKOH/g

The method only covers strong acids (e.g. sulfuric acid). If a SAN is proven, there is a risk of corrosion. The determination of the SAN is only necessary for combustion gases of the Low gas quality.

Ageing/oxidation

Unit: A/cm

Ageing/oxidation is caused by reaction of the basic oil and ingredient molecules with oxygen which leads to an increase in the viscosity and the Acid Number. Component smearing and sludge deposits can occur. The oxidation products can form organic acids which lead to corrosion even when the lubricating oil still has alkaline reserves.

The extinction at the wave number 1710 cm^{-1} in the infrared light spectrum is measured whereby the carbonyl compounds formed in the oxidation are measured.

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Nitration

Unit: A/cm

Nitration is caused by reactions of the basic oil and ingredient molecules with nitrogen oxides. The influences are comparable with those of the ageing/oxidation. They lead to changes in the lubricating oil parameters. However, the risk of corrosive reaction products is higher in comparison. In the case of strong nitration, a strong decomposition of the alkaline reserve usually also occurs.

The extinction at the wave factor cm^{-1} in the infrared light spectrum is measured.

i pH

Unit: none

The method serves to determine the pH value of the lubricating oil. The measurement result is specified in dimensionless pH value units. Over-acidification of the lubricating oil leads to corrosive wear.

Water

Unit: wt. %

Water in the lubricating oil generally leads to an emulsion which leads on the whole to increased wear and corrosion risk.

Water increases the viscosity of the lubricating oil.

Possible causes:

- Leaks in the coolant system
- Condensation processes in the lubricating oil system by frequent starts and emergency stops
- Improper storage of the lubricating oil
- Insufficient ventilation of the crankcase or lubricating oil tank
- Penetration of rain water into the exhaust system

Glycol

Unit: ppm

Glycol leads to formation of sludge and filter blockage due to reaction with the lubricating oil ingredients.

Glycol is incompatible with mineral oil.

Possible causes:

- Leaks in the coolant system
- Contamination with a lubricating oil based on polyglycol

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Interpretation of elements of the lubricating oil analysis

Silicon

Unit: mg/kg

Possible origin:

- Component in antifoaming ingredients
- Dust from the sucked-in air
  - leads to abrasive wear even in the smallest of amounts.
- Compounds of combustive gases (e.g. landfill, sewage and bio-gases)
  - The silicon load in the lubricating oil also gives an indirect indication of the silicon load of the combustive gas.

Sodium

Unit: mg/kg

Typical element of ingredients for corrosion protection in the coolant. Strong increase in the sodium content is a sign of contaminated coolant. The engine must be checked continuously for possible coolant leaks in the course of further operation.

In many cases no water can be found in the lubricating oil despite high sodium values and the associated contamination because this evaporates due to the lubricating oil temperature in engine operation.

Aluminum

Unit: mg/kg

Typical wear element of pistons and slide bearings for example.

Aluminum may also be a part of contaminated suction intake air under certain circumstances.

Iron

Unit: mg/kg

Typical wear element of cylinder liners, cams/tappets, shaft journals, piston rings and toothed wheels.

Chrome

Unit: mg/kg

Typical wear element of piston rings, valve stems, cams/tappets and other high alloyed engine components.

Copper

Unit: mg/kg

Typical wear element of bearings and corrosion product of lubricating oil coolers and lubricating oil lines.

Copper is also part of different mounting compounds.

Lead

Unit: mg/kg

Typical wear element of slide bearings and solder from lubricating oil coolers and lubricating oil lines.

The cause of a rapid change in the wear rate for lead and copper is frequently chemically corrosive wear (note limit value for i pH value).

Tin

Unit: mg/kg

Typical wear element of slide bearings.

Molybdenum

Unit: mg/kg

May be part of lubricating oil ingredients as well as different mounting compounds.

Also used as a running surface coating for sliding bearings.

Interpretation of optionally analyzed elements of the lubricating oil analysis

Potassium and boron

Unit: mg/kg

Typical elements of ingredients for corrosion protection in the coolant. An increase in the lubricating oil is a sign of a contamination by coolant.

However, boron is a typical element of frequently used ingredients in the lubricating oil.

Calcium, zinc, phosphorus, sulfur

Unit: mg/kg

Typical elements of ingredients in the lubricating oil.

Sulfur is also a part of the lubricating oil and combustive gases.

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Approved lubricating oils

Recommended lubricating oils with a sulfate ash content of up to 0.6 wt. %

Sulfate ash content up to 0.6 wt. %						
Manufacturer	Basic oils	Sulphate ash	TBN	Viscosity		
				Class	at 40 °C	at 100 °C
Product		Wt. %	mgKOH/g	SAE	mm^2/s	mm^2/s
MWM						
Premium GMO 240[1)]	Mineral	0.55	5.2	40	122.0	13.3
Premium GMO 440[1)]	Synthetic	0.42	5.4	40	127.0	13.5

[1)] Not available in all countries, please contact your MWM Service Partner

Lubricating oils with a sulfate ash content up to 0.6 wt. %

Sulfate ash content up to 0.6 wt. %						
Manufacturer	Basic oils	Sulphate ash	TBN	Viscosity		
				Class	at 40 °C	at 100 °C
Product		Wt. %	mgKOH/g	SAE	mm^2/s	mm^2/s
ADDINOL						
MG 40 Extra LA	Mineral	0.50	6.5	40	137.0	14.5
NG 40	Mineral	0.54	5.6	40	122.5	13.8
Eco Gas 4000 XD	Mineral	0.62	7.3	40	116.5	13.3
ARAL AG						
Degasol NGL	Mineral	0.45	5.1	40	130.0	13.5
AVIA						
Gas Engine Oil LA 40	Mineral	0.50	6.5	40	136.0	14.5
GMO LA-XT 40	Mineral	0.54	5.6	40	123.0	13.8
BAYWA						
Tectrol Methaflexx NG	Mineral	0.45	5.5	40	156.0	14.5
Tectrol Methaflexx NG Plus	Mineral	0.50	5.9	40	141.5	14.9
Tectrol Methaflexx NG Pro	Mineral	0.50	5.5	40	120.7	13.7
BP						
BP Energas NGL	Mineral	0.45	5.1	40	130.0	13.5

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Sulfate ash content up to 0.6 wt. %						
Manufacturer	Basic oils	Sulphate ash	TBN	Viscosity		
				Class	at 40 °C	at 100 °C
Product		Wt. %	mgKOH/g	SAE	mm^2/s	mm^2/s
CASTROL						
Duratec L	Mineral	0.45	5.1	40	130.0	13.5
Duratec HPL	Mineral	0.45	5.1	40	121.0	13.0
Duratec XPL	Synthetic	0.45	4.9	20W-40	109.0	14.0
CATERPILLAR						
NGEO Advanced 40	Mineral	0.50	6.0	40	115.0	13.0
NGEO Ultra 40	Mineral	0.54	6.0	40	125.0	13.0
CEPSA						
Troncoil Gas	Mineral	0.46	5.2	40	144.8	14.5
Troncoil Gas LD 40	Mineral	0.50	4.6	40	133.1	14.0
CHEVRON / CALTEX / TEXACO						
Geotex PX 40	Mineral	0.50	5.4	40	88.0	13.2
HDAX 5200 Low Ash	Mineral	0.50	4.2	40	124.0	13.5
HDAX 6500 LFG[1)]	Mineral	0.55	4.5	40	121.0	13.5
HDAX 9200 Low Ash	Mineral	0.50	4.2	40	124.0	13.5
[1)]**Recommended for use with sewage gas, landfill gas and other biogases**						
ENGEN						
GEO N-40	Mineral	0.50	5.5	40	125.8	14.0
ENI						
Autol ELA 40	Mineral	0.50	5.5	40	138.0	14.0
GEUM NG	Mineral	0.50	5.5	40	124.0	13.6
ENOC						
Khaura LA 40	Mineral	0.50	5.4	40	119.3	13.6
EUROLUB						
LA SAE 40	Mineral	0.50	5.5	40	138.0	14.0
EXOL						
Taurus GEO G240	Mineral	0.49	5.5	40	126.0	13.8

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Sulfate ash content up to 0.6 wt. %						
Manufacturer	Basic oils	Sulphate ash	TBN	Viscosity		
				Class	at 40 °C	at 100 °C
Product		Wt. %	mgKOH/g	SAE	mm^2/s	mm^2/s
FUCHS						
Titan Ganymet LA	Mineral	0.45	5.5	40	156.0	14.5
Titan Ganymet Plus LA	Mineral	0.50	6.6	40	142.1	15.1
Titan Ganymet Pro LA	Mineral	0.50	5.5	40	120.7	13.7
GALP						
Galp GNX 4005	Mineral	0.50	5.4	40	88.0	13.2
Power Gas NGB 40	Mineral	0.50	5.5	40	122.0	13.5
GAZPROMNEFT						
G-Profi PSN 40	Mineral	0.49	5.5	40	125.8	14.0
GULF OIL						
Gulfco LA Supreme	Mineral	0.50	5.4	40	124.0	14.4
HESSOL						
Gas Engine Oil Low Ash	Mineral	0.50	6.5	40	137.0	14.5
Gas Engine Oil SAE 40 LA Pro	Mineral	0.54	5.6	40	122.5	13.8
HILL Corporation LLC						
Fastroil Gas Engine Oil SAE40	Mineral	0.50	5.3	40	128.5	13.5
I.G.A.T.						
Platin Cogeneration Oil SAE 40	Mineral	0.50	5.4	40	124.0	13.6
KUWAIT PETROLEUM - Q8						
Mahler MA	Mineral	0.50	5.5	40	138.0	14.0
Mahler G4	Mineral	0.40	5.5	40	120.0	13.3
Mahler G5	Mineral	0.50	6.0	40	120.0	13.3
MOBIL						
Pegasus 605[1)]	Mineral	0.52	7.1	40	126.0	13.3
Pegasus 605 Ultra[1)]	Mineral	0.60	5.3	40	137.5	15.0
Pegasus 805	Mineral	0.54	6.2	40	130.0	13.5
Pegasus 1005	Mineral	0.50	5.0	40	125.0	13.0
Pegasus 1	Synthetic	0.51	6.5	15W-40	93.8	13.0

[1)] Recommended for use with sewage gas, landfill gas and other biogases.

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Sulfate ash content up to 0.6 wt. %						
Manufacturer	Basic oils	Sulphate ash	TBN	Viscosity Class	at 40 °C	at 100 °C
Product		Wt. %	mgKOH/g	SAE	mm²/s	mm²/s
MORRIS LUBRICANTS						
GEO Ultra 40	Mineral	0.50	5.5	40	121.1	13.7
MOTOREX						
Evolube NG SAE40	Mineral	0.50	5.5	40	125.0	13.9
NILS						
Burian Light	Mineral	0.50	6.5	40	136.0	14.5
NIS						
Nisotec GEO NBG	Mineral	0.50	5.4	40	120.5	13.5
NORTH SEA LUBRICANTS						
Tidal Power LA 40	Mineral	0.49	6.0	40	144.0	14.5
OILFINO						
Famagas LA 40	Mineral	0.48	5.6	40	147.0	14.3
Linogas LA 40	Mineral	0.49	5.2	40	123.0	13.6
ORI-TECH						
Gas Engine Oil 40 C	Mineral	0.49	5.5	40	119.8	14.0
ORLEN OIL						
Delgas L 40	Mineral	0.50	5.4	40	126.0	13.9
PEAK						
Navitus MA	Mineral	0.50	5.5	40	138.0	14.0
Navitus G5	Mineral	0.50	6.0	40	120.0	13.3
PETRO-CANADA						
Sentron LD 3000	Mineral	0.47	3.9	40	124.0	13.7
Sentron LD 5000	Mineral	0.57	4.8	40	124.0	13.4
PETRONAS						
GEO NG	Mineral	0.48	5.4	40	121.8	13.5
PT. PERTAMINA LUBRICANTS						
NG Lube HSG 40	Mineral	0.49	5.5	40	124.0	14.0

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Sulfate ash content up to 0.6 wt. %						
Manufacturer	Basic oils	Sulphate ash	TBN	Viscosity		
				Class	at 40 °C	at 100 °C
Product		Wt. %	mgKOH/g	SAE	mm^2/s	mm^2/s
REPSOL						
Extra Gas 40	Mineral	0.50	6.0	40	133.0	13.5
Super Motor Gas 4005	Mineral	0.50	6.4	40	129.0	13.0
Long Life Gas 4005	Mineral	0.50	5.1	40	118.0	13.2
ROLOIL						
Mogas 40	Mineral	0.50	5.5	40	138.0	14.0
Mogas G4	Mineral	0.40	5.5	40	120.0	13.3
Mogas G5	Mineral	0.50	6.0	40	120.0	13.3
Mogas XNG	Mineral	0.50	5.5	40	122.2	13.5
ROWE						
Hightec Powerplant SAE40	Mineral	0.50	5.4	40	124.0	13.6
SASOL						
Gas Engine Oil LA 40	Mineral	0.50	5.5	40	127.0	14.0
SHELL						
Mysella S3 N	Mineral	0.45	5.0	40	139.0	14.0
Mysella S5 N	Mineral	0.48	4.5	40	125.0	13.7
Mysella S5 S[1)]	Mineral	0.57	5.3	40	135.0	13.5

[1)] Recommended for use with sewage gas, landfill gas and other bio gases.

SINOPEC						
GS200-L	Mineral	0.50	5.5	40	116.8	13.1
SRS						
Mihagrun LA 40	Mineral	0.48	5.6	40	147.0	14.3
Mihagrun LAX 40	Mineral	0.50	5.0	40	123.0	13.6
SYNLUBE						
GEO LD40	Mineral	0.50	5.5	40	135.5	14.0

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Sulfate ash content up to 0.6 wt. %						
Manufacturer	Basic oils	Sulphate ash	TBN	Viscosity		
				Class	at 40 °C	at 100 °C
Product		Wt. %	mgKOH/g	SAE	mm^2/s	mm^2/s
TOTAL						
Nateria MH 40	Mineral	0.43	5.5	40	142.2	14.8
Nateria MP 40	Mineral	0.50	4.6	40	133.1	14.0
WIPA CHEMICALS INTERNATIONAL						
Ecosyn GE 4004	Synthetic	0.40	5.5	40	135.0	13.7
Esosyn GE 4006[1)]	Synthetic	0.60	7.5	40	156.0	13.9
Ecosyn GE C104	Synthetic	0.40	5.5	40	135.0	13.7

[1)] Recommended for use with sewage gas, landfill gas and other biogases.

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Gas Engine Oil LA 40	Mineral	0.49	6.0	40	144.0	14.5

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Lubricating oils with a sulfate ash content of 0.6 to 1.0 wt. %

Sulfate ash content of 0.6 to 1.0 wt. %						
Manufacturer	Basic oils	Sulphate ash	TBN	Viscosity		
				Class	at 40 °C	at 100 °C
Product		Wt. %	mgKOH/g	SAE	mm²/s	mm²/s
ADDINOL						
MG 40 Extra Plus	Mineral	0.85	9.8	40	133.0	14.2
AVIA						
Gas Engine Oil HA 40	Mineral	0.85	9.8	40	133.0	14.2
BAYWA						
Tectrol Methaflexx HC Premium	Mineral	0.70	8.2	40	105.0	13.4
Tectrol Methaflexx HC Plus	Mineral	0.80	9.2	40	132.0	14.5
Tectrol Methaflexx GE-M	Mineral	0.90	7.9	40	141.2	14.1
Tectrol Methaflexx D Plus	Mineral	1.00	10.6	40	137.0	15.0
CASTROL						
Duratec M	Mineral	0.72	7.5	40	125.0	13.0
CHEVRON / CALTEX / TEXACO						
Geotex LF 40	Mineral	0.99	8.0	40	138.0	14.0
ENI						
Autol BGJ 40	Mineral	0.90	7.9	40	141.2	14.1
EUROLUB						
HGM Plus SAE 40	Mineral	0.90	7.9	40	141.2	14.1
FUCHS						
Titan Ganymet Plus	Mineral	0.80	9.2	40	132.0	14.5
Titan Ganymet Ultra	Mineral	0.70	8.2	40	105.0	13.4
HESSOL						
Gas Engine Oil SAE 40	Mineral	0.85	9.8	40	133.0	14.2
KUWAIT PETROLEUM - Q8						
Mahler HA	Mineral	0.90	7.9	40	141.2	14.1
Mahler G8	Mineral	0.80	8.0	40	120.0	13.3
NILS						
Burian SAE 40	Mineral	0.85	9.8	40	133.0	14.2

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Sulfate ash content of 0.6 to 1.0 wt. %						
Manufacturer	Basic oils	Sulphate ash	TBN	Viscosity		
				Class	at 40 °C	at 100 °C
Product		Wt. %	mgKOH/g	SAE	mm^2/s	mm^2/s
PEAK						
Navitus HA	Mineral	0.90	7.9	40	141.2	14.1
Navitus G8	Mineral	0.80	8.0	40	120.0	13.3
PHI OIL						
Gas Engine Oil MA 40	Mineral	0.91	9.8	40	133.0	14.2
ROLOIL						
Mogas 40 AC	Mineral	0.90	7.9	40	141.2	14.1
Mogas G8	Mineral	0.80	8.0	40	120.0	13.3
TOTAL						
Nateria MJ 40	Mineral	0.82	8.8	40	148.0	15.1

Service Information

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