LIQUI MOLY ACADEMY

LIQUI MOLY
Lubricant ABC
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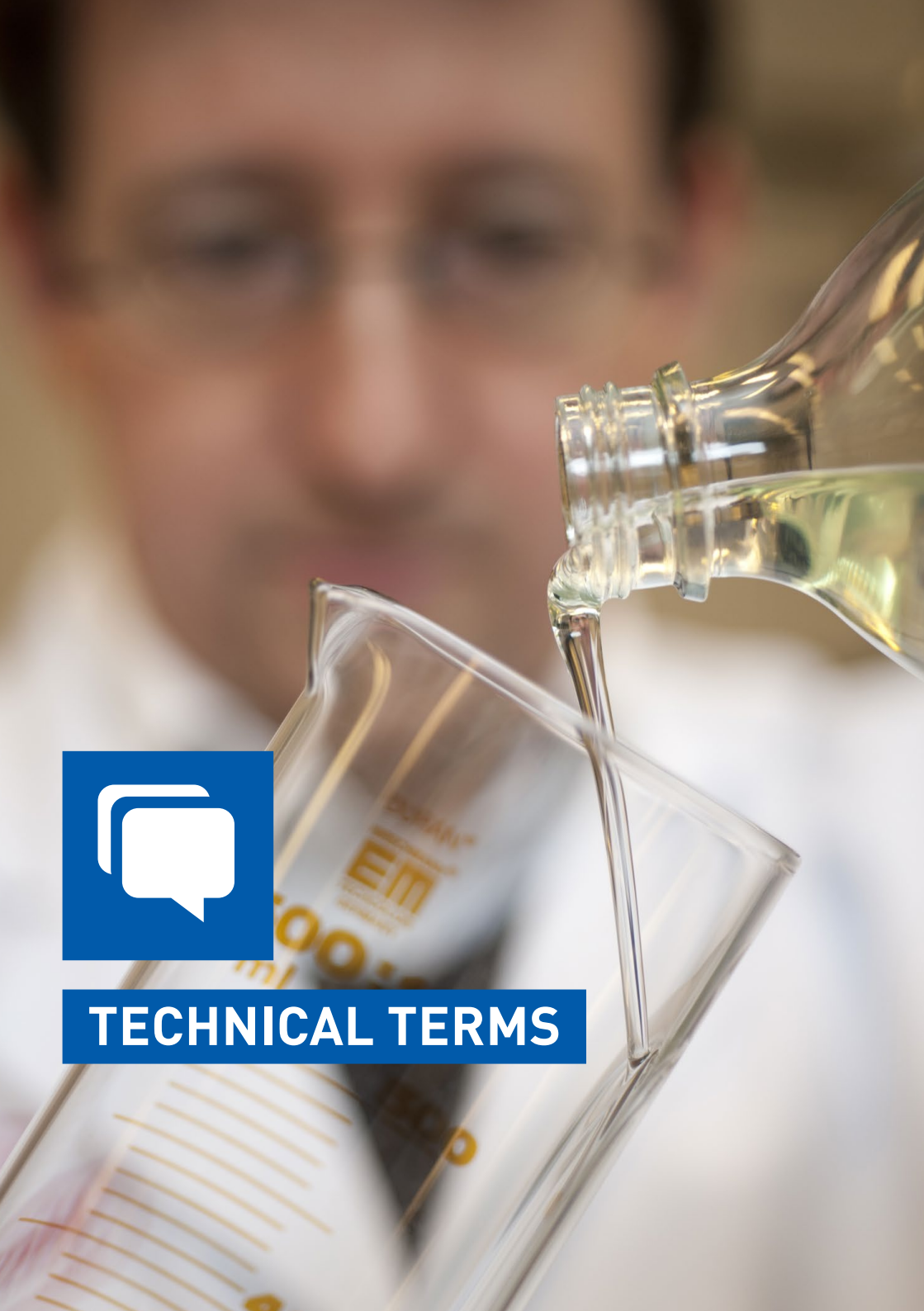


TECHNICAL TERMS

1. Terms from A – Z

ACEA

ACEA (Association des Constructeurs Européens d'Auto mobiles) has been the official successor organization of CCMC since 1/1/1996. It defines the quality of motor oils according to the requirements of European engine manufacturers.

ADDITIVE PACKAGE

An additive package is a mixture of various chemical materials that influence the properties of the motor oil in different ways.

ALKALINE RESERVES

The alkaline reserves of an oil neutralize acidic reaction products, which are created during the combustion of fuel.

API

The American Petroleum Institute (API) determines the global quality requirements and testing criteria for lubricants. Europe or European manufacturers are excluded from this for the most part.

ATF

So-called Automatic Transmission Fluids (ATF) have a defined friction value and have a high viscosity index. The oils are mainly used in automatic transmissions and power steering.

BACKWARDS COMPATIBLE

A specification or approval is backwards compatible if it meets and exceeds the previous (then obsolete) specification or approval.

BASE NUMBER

The base number shows the quantity of alkaline reserves in motor oils. In used oils the base number gives an idea of the remaining additives that have not yet been used.

BASE OIL

Base oil is the base product for the manufacture of lubricating oils. Base oils (mineral, hydrocracked or fully synthetic) are manufactured by various refinery processes.

BORDERLINE PUMPING VISCOSITY
The borderline pumping viscosity describes the test for classification of the lubricants into the respective SAE classes. The viscosity of the corresponding SAE class must not be exceeded at a defined temperature here to ensure that the lubricant continues to flow on its own.

CATALYTIC HYDROCRACKING
During catalytic hydrocracking, in the presence of a catalytic converter (e.g. synthetic aluminosilicates), and at a temperature of 500 °C the molecule chains are broken.

CRACKING
In cracking, long hydrocarbon molecules are broken up. These broken molecule chains form the base product for synthetic oils.

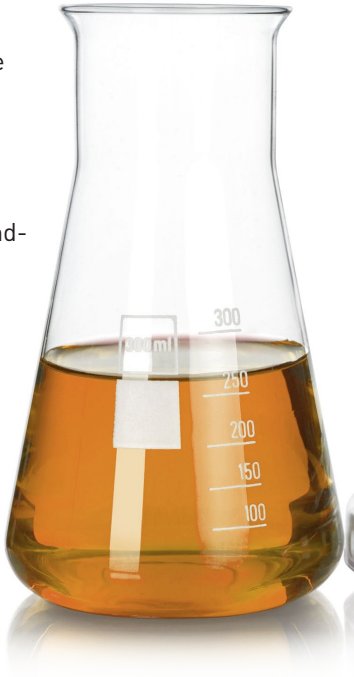
CRUDE OIL
Crude oil is a mixture mainly made up of hydrocarbons, which is created by the decomposition process of organic materials.

DETERGENTS
Detergents are wash-active substances that protect the engine against deposits. Also, detergents form the so-called alkaline reserves.

DEWAXING
During dewaxing wax crystals are removed from the corresponding distillate, in order to improve the pour point (the lowest temperature in which the oil is still flowing, when it is cooled under certain conditions).

DISPERSANTS
The dispersants contained in the motor oil envelop solid and liquid contaminants in the oil and transport them to the oil filter.

DISTILLATION
During distillation crude oil is heated under atmospheric pressure and disassembled into its natural components.



EP ADDITIVES
Extreme Pressure additives (EP) form a "protective layer" on the metal surfaces under high pressure and great heat.

FRICTION MODIFIER
Friction modifiers (FM) create weak bonds with metal surfaces and thereby reduce or increase the friction properties of a lubricant.

FULLY SYNTHETIC BASE OIL
Oils based on poly-alpha-olefins are referred to as fully synthetic base oils. These are manufactured synthetically and have high temperature and aging stability.

GL
GL means "Gear Lubricant" and identifies the pressure stability of a gear oil according to API.

HTHS VISCOSITY
High Temperature High Shear (HTHS) is the dynamic viscosity of a liquid measured at 150 °C under the influence of high shear forces.

HYDROCRACKED BASE OIL
Hydrocracked base oils are manufactured based on paraffin. These oils are currently state-of-the-art and are also used in cutting edge gasoline/diesel engines.

HYDROCRACKING
During hydrocracking, long molecule chains are broken up in the presence of hydrogen. This hydrogen stores itself in the open chain ends and "repairs" the breakage.

HYDROFINISHING
Hydrofinishing is the addition of hydrogen during the manufacturing of mineral base oil for ensuring optimum aging stability.

JASO
The Japanese Automotive Standards Organisation (JASO) divides lubricating oils into various classes and is mainly used in the motorbike sector or in Asia.

MINERAL BASE OIL
Mineral base oils are a direct product of crude oil distillation. This type of base oil is no longer used in modern engines.

NAPHTA
Naphta is petroleum, which represents a product of crude oil distillation.

PARAFFIN
Wax crystals that form the byproduct of the manufacture of mineral base oil are described as paraffin.

POUR POINT
The pour point is the lowest temperature at which the oil just about flows when it is cooled down under certain conditions.

POUR POINT DEPRESSANT
A Pour Point Depressant (PPD additive) changes the structure of the wax crystals in the base oil and delays their growth. This minimizes the solidification point of the oil or improves the low temperature property.

REFINING
Refining is the removal/conversion of unwanted parts from vacuum distillation.

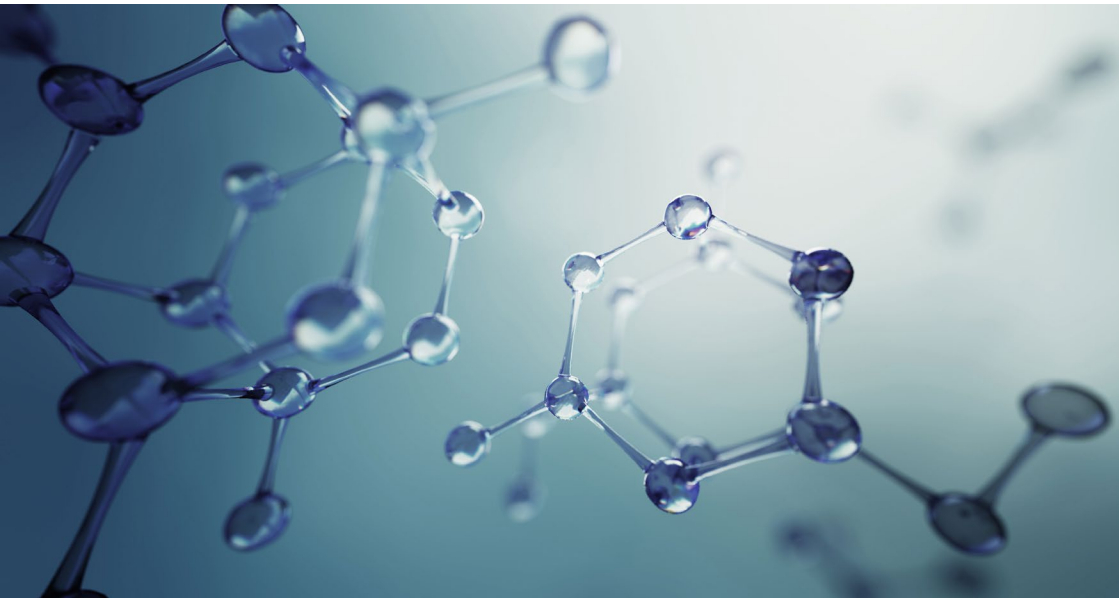
SAE INTERNATIONAL
SAE International (formerly the Society of Automotive Engineers) specifies the valid viscosity classes for motor and gear oils in the automotive industry, which manufacturers around the world conform to.

VACUUM DISTILLATION
In vacuum distillation objects are separated from distillation of the raffinate under a vacuum. With the vacuum the boiling point can be reduced by approx. 150 °C and therefore the cracking of the molecules is prevented.

VISCOSITY
Viscosity is the resistance (inner friction) of a fluid. The higher the resistance, the more viscous the oil is. The viscosity in motor and gear oils is given according to SAE.

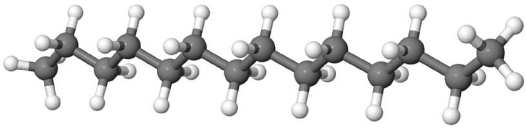
VISCOSITY INDEX
The viscosity index (VI) describes the viscosity/temperature behavior of the oil. The higher the VI, the lower the change in viscosity across the entire temperature range.

VISCOSITY INDEX IMPROVERS
Viscosity index improvers are polymers that are constructed in such a way that they influence the temperature-dependent viscosity change of an oil.

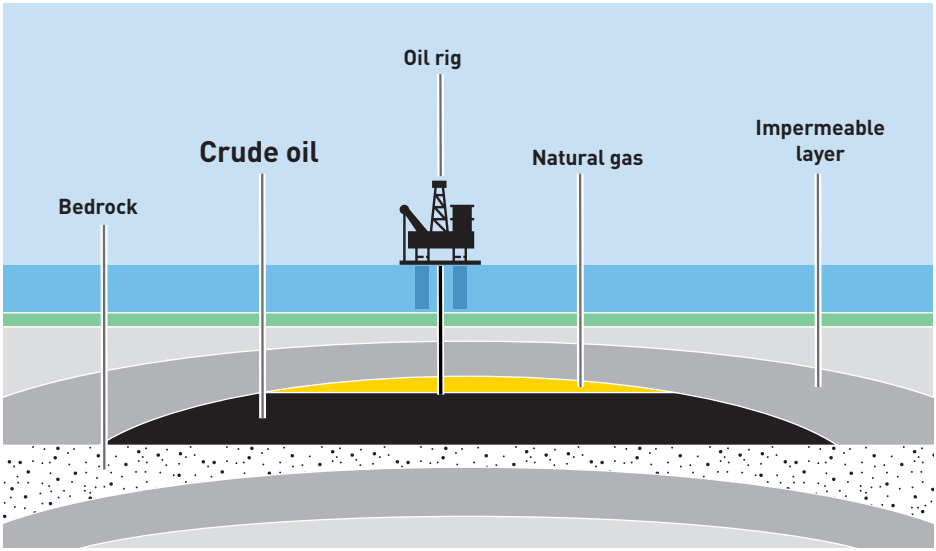



BASICS

2. Crude oil

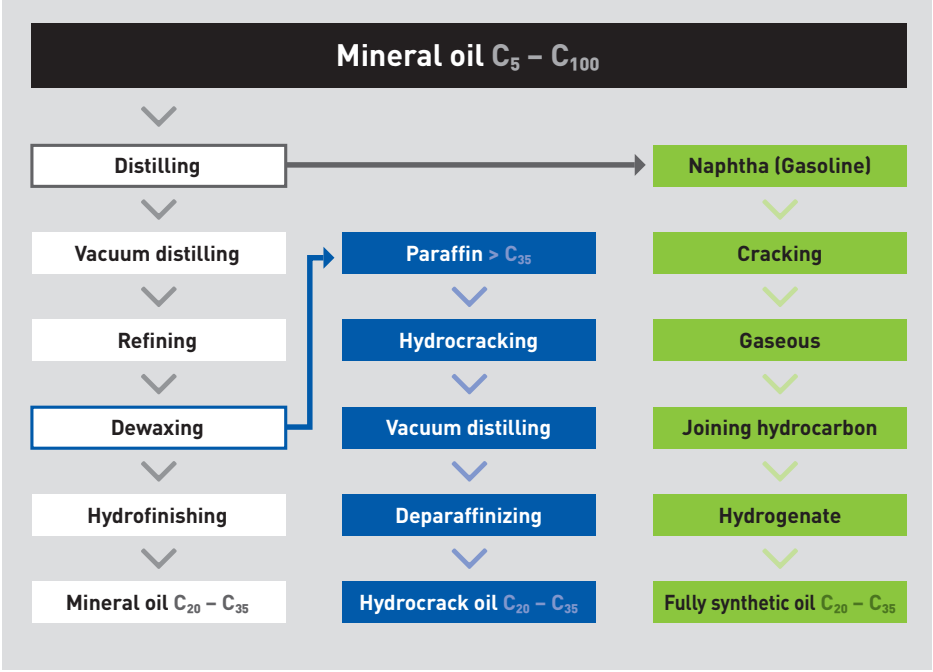


Crude oil was created by dead plankton that sank to the bottom of the seabed millions of years ago. Over the course of time, sand and stones built up on top of it. Due to this impermeable layer and under oxygen exclusion, pressure and heat, the conversion of these "lifeforms" into crude oil took place. The basic building blocks of crude oil are hydrocarbon compounds, which can occur in various chain lengths (C_5 - C_{100}).



3. Various base oils

Base oils form the base product for the manufacturing of motor oils. The various base oils (mineral, hydrocracked or fully synthetic) are manufactured by various refinery processes (see sketch).



3.1 Mineral base oil

Mineral base oil is the simplest and oldest form of base oil. In manufacturing the already described crude oil serves as a direct base product. The crude oil is heated in a furnace and disassembled into its natural components (distilled). Then unwanted and damaging components are removed from the distillate by the refining process or by dewaxing. Thanks to the subsequent hydrofinishing, the raffinate specifically has hydrogen added to it, which closes the open molecule chains and therefore significantly increases the aging stability.

3.2 Fully synthetic base oil

Fully synthetic base oil is mainly characterized by its very good thermal stability and cleaning performance. As high performance as it is, so laborious its manufacture also is. So-called naphtha (gasoline without additives) serves as the base product. Naphta is cracked in the first step, which means that the molecule chains (C_5 – C_{12}) are split open and are broken down to a length of C_2. The former liquid is now gaseous. In the consequent synthesis process the short molecule chains (C_2) are added to long molecule chains (C_{20} – C_{35}) and sealed by adding hydrogen (hydrogenation).

3.3 Hydrocracked base oil

Hydrocracked base oil combines the positive properties of mineral and fully synthetic base oils with one another. This base oil type offers a very good thermal stability and resistance to aging with simultaneously absolute material compatibility. The basis for hydrocracked base oils is formed by the paraffin taken from the mineral oil extraction. The paraffin is made up of long-chained molecule compounds (> C_{35}). These are split open in the presence of a catalytic converter under a pressure of 70 - 200 bar and temperatures of up to 500 °C and shortened to a useful length of C_{20} – C_{35} (catalytic hydrocracking). The liquid in the vacuum is subsequently distilled, in order to avoid the cracking of the molecule chains. In the last step, any paraffin deposits are removed

4. Additive package

In most cases the base oil alone is not sufficient to cover the many tasks that an oil has to fulfill in an engine, for example. For a reliable lubrication and seamless operation so-called additives are added to the base oils. With the help of these additives, certain properties of the oil can be improved or completely new properties achieved. The list of the additives used for this is varied and long. The individual materials are, depending on the requirement, comprised in an additive package. This package is added to the base oil, heated from 70 °C to 75 °C and stirred until it is completely dissolved in the oil. In modern motor oils the concentration of additives can be up to 30 % or less than 1 % in gear oils.

Fundamentally, you can differentiate between two types of additives:

- Additives that have an effect on the base oil, e.g. pour point improvers, anti-foam additives or viscosity index improvers.
- Additives that have an effect on the material surfaces (bearings, cylinders ...), e.g. bonding enhancers or friction modifiers (friction value improvers).

Here is a list of the properties of an oil that can be influenced by additives:

Characteristics	Influenceable by additives	Only possilbe by additives	Not influenceable by additives
Low-temperature behavior	●	○	○
Aging stability	●	○	○
Viscosity/ temperature behavior	●	○	○
Corrosion protection	●	○	○
Dirt solving ability	●	●	○
Dispersing power	●	●	○
High pressure properties	●	●	○
Foaming characteristics	●	●	○
Air discharging	○	○	●
Water separation	○	○	●

4.1 Detergents

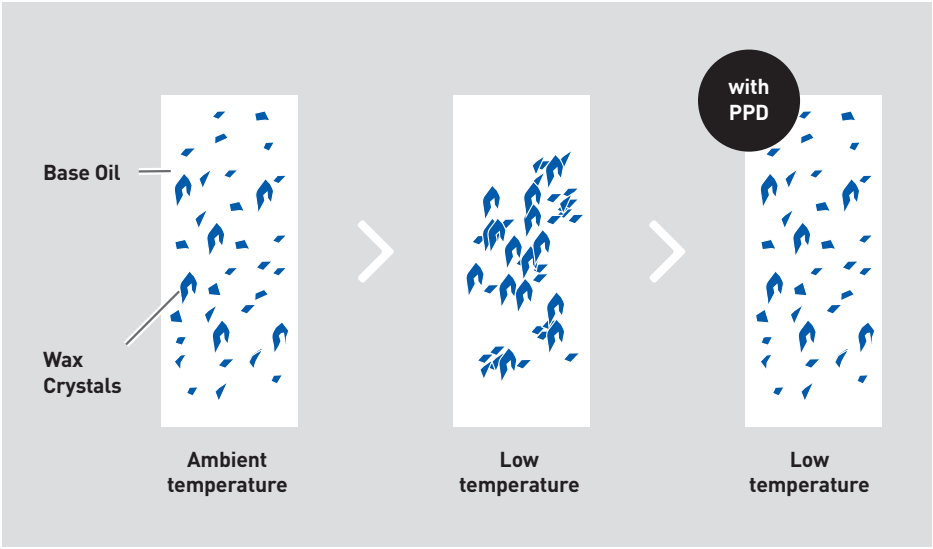
Detergents are wash-active substances in the oil, which prevent the formation of deposits or free the engine of them. If these are used up by exceeded oil change intervals, for example, the result is the increased formation of deposits (see picture). This causes friction to measurably increase in the engine, risking engine damage.

4.2 Extreme Pressure Additives

Extreme pressure additives (EP additives) are added to the oil in the form of sulfur or phosphorus compounds to prevent fusion caused by high pressures or loads of the friction partners. In this case, EP additives in lubricants are indispensable. High temperatures form in the lubricant under high pressures or loads. When this happens, sulfur (sulfur carriers) or a phosphorus derivative (phosphoric compounds) is released from the EP additive. The released substance immediately reacts with the metal surface under these conditions to create metallic sulfides or metallic phosphates. These compounds form layers on the metal surface that are sheared off as lamellae under high pressure. This prevents the fusion and thereby the seizing of metal surfaces.

4.3 Pour Point Depressant (PPD)

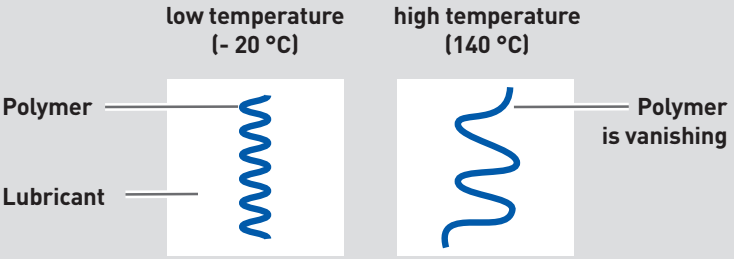
The PPD additive is used to reduce the solidification point of the lubricant and therefore improve the low temperature properties. The wax crystals included in base oil are changed in their structure by the additive and their growth is significantly slowed down at low temperatures.



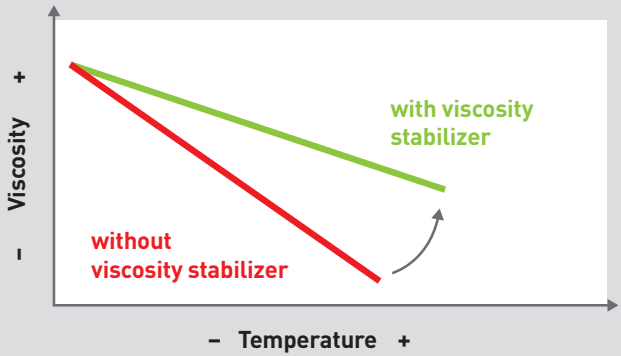
4.4 Viscosity index improvers

Viscosity index improvers are macromolecular polymers (combination of macromolecules) that are constructed in such a way that they influence the temperature-dependent viscosity change of an oil. The polymer contracts at low temperatures. This makes the resistance that the polymer opposes an invading body with smaller and the viscosity change of the base oil is equalized.

The image shows how this mechanism works:



Graphical description:

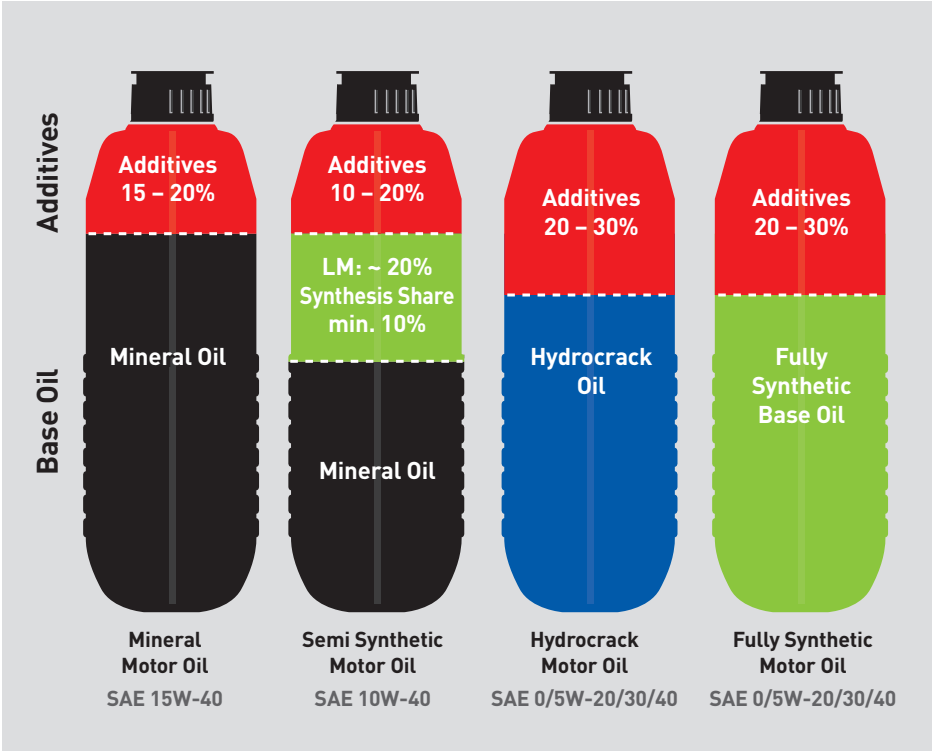


Note: The higher the viscosity index of an oil, the lower the change in viscosity is over a wide temperature range.

4.5 Anti-foam additives

An unwanted byproduct of circulation lubrication is the inclusion of small air bubbles in the motor oil. Anti-foam additives cause a significant reduction of foam created in the circulation of oil (air pockets).

4.6 Additive share in motor oils



CLASSIFICATION

5. Classification of motor oil

In order to select the correct motor oil, two pieces of information are required. Firstly, the viscosity, and, secondly, the quality is required. Numerous organizations have arisen over the past few decades for these classifications:

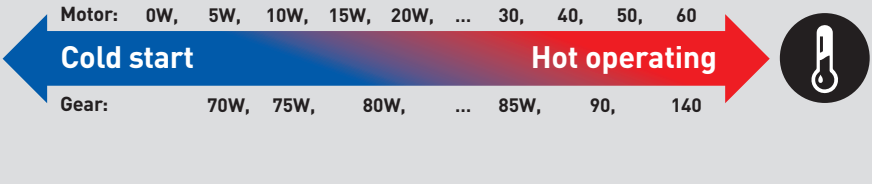
- **SAE** (Society of Automotive Engineers)
- **API** (American Petroleum Institute)
- **ACEA** (Association des Constructeurs Européens d'Automobiles)
- **ILSAC** (International Lubricant Standardization and Approval Committee)
- **JASO** (Japanese Automotive Standards Organization)

The well-known European vehicle or engine manufacturers (Mercedes-Benz, BMW, VW ...) conform to SAE for viscosity information and ACEA for quality information. The motor oils to be used for import vehicles that were developed outside of Europe (Toyota, Mitsubishi, Chrysler ...) mainly conform to API or ILSAC and SAE; on diesel vehicles with DPF these increasingly conform to ACEA.

Tip: You can find the specifications and approvals on the front of our products.

5.1 Classifications by SAE

The viscosity only provides information about the siziness (internal friction) of an oil and thus does not define any qualitative properties. This means that an oil that satisfies a viscosity according to SAE has prescribed flow properties at different temperatures. The viscosity is sub-divided into the cold start range with the attached letter "W" (e.g. 5W). As the number in front of the "W" gets smaller, the oil becomes better capable of flow at low temperatures. The number without the attached letter (e.g. 30) is valid for the range at operating temperature. The higher the number, the more viscous the oil at 100 °C.



The minimum low temperature at which a motor/gear oil can be used depends on the possible borderline pumping temperature or the low-temperature viscosity.

Limit temperature for motor oil

SAE 0W	- 40 °C
SAE 5W	- 35 °C
SAE 10W	- 30 °C
SAE 15W	- 25 °C
SAE 20W	- 20 °C
SAE 25W	- 15 °C

Low temperature viscosity (max. 150,000 mPa*s)

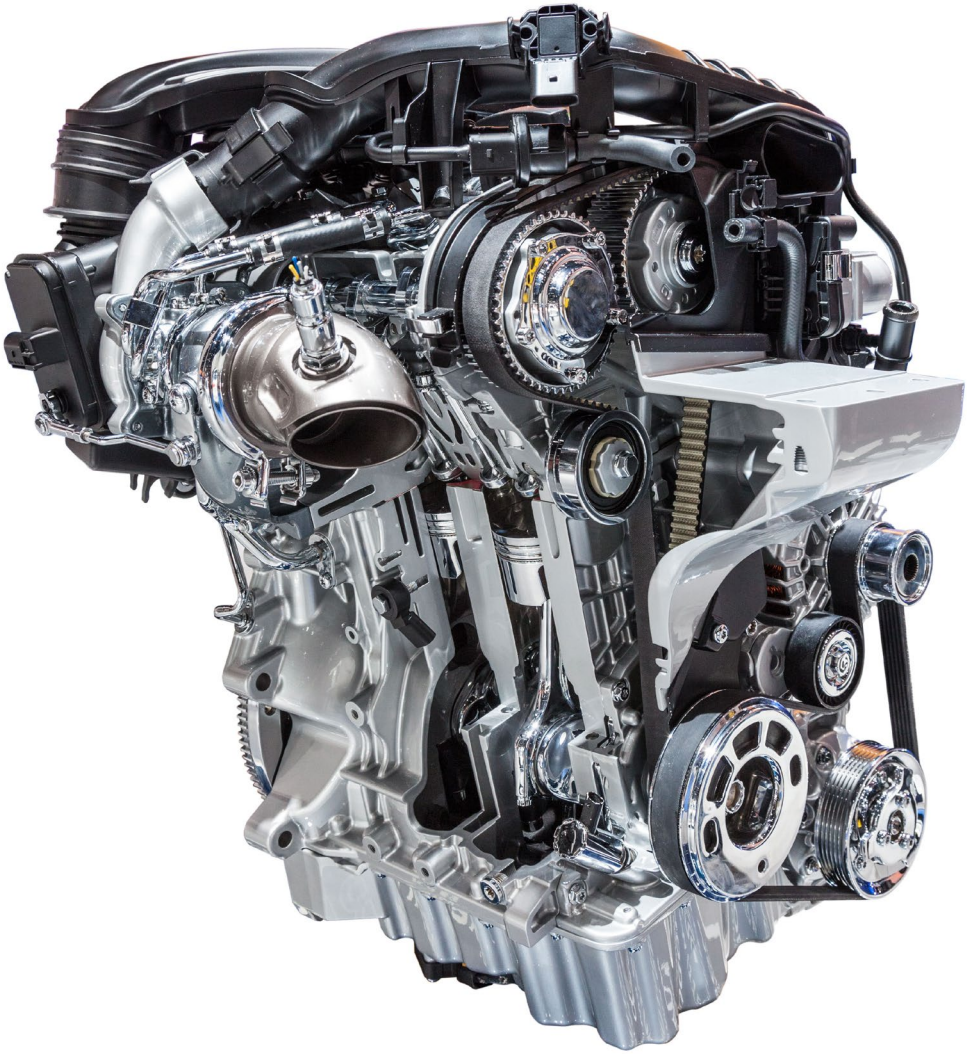
SAE 70W	- 55 °C
SAE 75W	- 40 °C
SAE 80W	- 26 °C
SAE 85W	- 12 °C

5.2 Classifications by API

The American Petroleum Institute generally differentiates between two types of motor oils: motor oils for gasoline engines (S) and motor oils for diesel engines (C). The letter following the initial "S or C" letter, e.g. "G" or "H", defines the quality of the lubricant. The further along in the alphabet this letter is, the higher the grade of the motor oil. The higher specifications such as API SM or SN can be used for preceding classifications, e.g. API SL, without hesitation in accordance with API. Motor oils for diesel engines may also be shown with an additional "-4". This addition denotes the suitability for large-volume 4-stroke diesel engines such as in trucks or buses (heavy duty). API CF-2 stands for the quality of a 2-stroke diesel engine.

5.3 Classifications by ACEA

The Association des Constructeurs Européens d`Automobiles forms the oil standard for European vehicle or engine manufacturers. Here – as with API – oils for gasoline engines (A) and light diesel engines (B) are differentiated. Unlike with the API, at the ACEA every category has its own meaning and cannot be used backwards compatibly.



5.3.1 Car gasoline and diesel engines

A1/B1 High-performance motor oil for gasoline and diesel engines, so-called fuel economy motor oils with particularly low High Temperature High Shear viscosity (2.9 - 3.5 mPA*s). Reserved for viscosity class xW-20. Invalid since 12/2016.

A3/B4 High-performance motor oil for gasoline and diesel engines, extends and replaces conventional motor oils like ACEA A2/B2 and A3/B3 and can be used for extended change intervals.

A5/B5 High-performance motor oil for gasoline and diesel engines, so-called fuel economy motor oils with particularly low High Temperature High Shear viscosity (2.9 - 3.5 mPa*s). Reserved for viscosity class xW-30.

5.3.2 Car diesel engines with diesel particulate filters

C1 Category for Low SAPS oil with reduced HTHS viscosity ≥ 2.9 mPa*s, low viscosity, performance as with A5/B5, but with very limited proportions of sulfate ash, phosphorus, sulfur.

C2 Category for Mid SAPS oil with reduced HTHS viscosity ≥ 2.9 mPa*s, low viscosity, performance as with A5/B5, with limited, but higher proportions of sulfate ash, phosphorus, sulfur compared to C1.

C3 Category for Mid SAPS oil with high HTHS viscosity ≥ 3.5 mPa*s, low viscosity, performance as with A3/B4, with limited, but higher proportions of sulfate ash, phosphorus, sulfur compared to C1.

C4 Category for Low SAPS oil with high HTHS viscosity ≥ 3.5 mPa*s, low viscosity, performance as with A3/B4, with the same proportions of sulfate ash and sulfur, but increased proportion compared to C1.

C5 C5 category for Mid SAPS oil with reduced HTHS viscosity 2.6 – 2.9 mPas*s, low viscosity, for even more improved and optimum fuel savings, for vehicles with state-of-the-art exhaust aftertreatment systems, only for engines meeting the corresponding technical requirements.

5.3.3 Commercial vehicle diesel engines

E1/E2 Category not up to date.

E3 Category is included in ACEA E7.

E4 Based on MB 228.5, extended oil change possible, suitable for Euro 3 engines.

E5 Category is included in ACEA E7.

E6 Category for EGR engines with/without diesel particulate filters (DPF) and SCR-NO_x engines. Recommended for engines with diesel particulate filters combined with sulfur-free fuel. Sulfate ash content max. 1 %.

E7 Category for engines without diesel particulate filters (DPF) of most EGR engines and most SCR-NO_x engines. Sulfate ash content max. 2 %.

E9 Category for engines with/without diesel particulate filters (DPF) of most EGR engines and most SCR-NO_x engines. Recommended for engines with diesel particulate filters combined with sulfur-free fuel. Sulfate ash content max. 1 %.

5.4 Classifications by ILSAC

The International Lubricants Standardization and Approval Committee is very strongly based on the categories according to API in its classification of motor oils. There are five classification categories for gasoline engines, but none for diesel engines.

ILSAC	
GF-1	introduction year 1996, comparable with API SH, category not up to date
GF-2	introduction year 1997, comparable with API SJ
GF-3	introduction year 2001, comparable with API SL
GF-4	introduction year 2004, comparable with API SM
GF-5	introduction year 2010, comparable with API SN

5.5 Classifications by JASO

The Japanese Automobile Standard Organisation sets out the criteria for two-wheel oils. Here increased requirements of friction behavior (wet clutches), shear stability and burning behavior are set out. The JASO and API classifications always occur together in the two-wheel sector.

JASO	
MA	4-stroke engines – high friction value for motorbikes with wet clutches
MA 2	4-stroke engines – high friction value for motorbikes with wet clutches and transmission properties
MB	4-stroke engines – low friction value for motorbikes without wet clutches
FB	2-stroke engines – low cleaning, incomplete combustion
FC	2-stroke engines – high cleaning, almost complete combustion
FD	2-stroke engines – highest cleaning, complete combustion

CAR SPECIFICATIONS

6. Car manufacturer specifications

Originating from European vehicle manufacturers, their prescribed manufacturer specifications are based on the engine tests of the ACEA. In order to achieve a manufacturer approval for a certain oil, in addition to the respective ACEA test procedure further engine tests and requirements must be satisfied. An overview of which manufacturer specification is based on which ACEA classification can be found on the following page.

Standard SAPS

A3/B3	A3/B4	A5/B5	DPF/CAT C1
VW 501 01/505 00	VW 502 00/505 00	Mercedes-Benz MB-Approval 229.6	
	MB-Approval 229.3/.5 MB-Approval 226.5	BMW Longlife-01 FE	
	BMW Longlife-01	Renault RN 0700	
Mercedes-Benz MB-Approval 229.1	Renault RN 0700 Renault RN 0710	Ford WSS-M2C 913-C WSS-M2C 913-D	Ford M2C934-B
Porsche A40	Fiat 9.55535-H2 Fiat 9.55535-M2, N2, Z2	Volvo VCC 95200377	Jaguar/Land Rover STJLR.03.5005 STJLR.03.5007
Fiat 9.55535-G1, G2, D2	Peugeot/Citroën PSA B71 2296 PSA B71 2300	Volvo VCC 95200377	
Peugeot/Citroën PSA B71 2294		Volvo VCC 95200377	Peugeot/Citroën PSA B71 2296
High level Gasoline/diesel Fuel saving	High level Gasoline/diesel (incl. DI Diesel)	High level Gasoline/diesel (incl. DI Diesel)	Low SAPS Fuel saving (reduced HTHS)

HTHS = High Temperature High Shear Rate viscosity,
DPF = diesel particulate filter, CAT = catalytic systems,
SAPS = Sulfated Ash Phosphorus Sulfur

Low and Mid SAPS

C2	C3	C4	C5
DPF / CAT	DPF / CAT	DPF / CAT	DPF / CAT
BMW Longlife-12 FE	VW 504 00 / 507 00		
Toyota Other Japanese	MB-Approval 229.31 MB-Approval 229.51 / .52		
Volvo VCC RBSO-2AE	Porsche A40 Porsche C30		
Fiat 9.55535-S1 Fiat 9.55535-GS1, DS1	BMW Longlife-04		
Ford M2C948-B Ford M2C950-A	Fiat 9.55535-S2, S3, GH2 Fiat 9.55535-T2		VW 508 00 / 509 00
Peugeot / Citroën PSA B71 2290 PSA B71 2312	Opel GM dexos2	Mercedes-Benz MB-Approval 226.51	Mercedes-Benz MB-Approval 229.71
	Peugeot/Citroën PSA B71 2297	Renault RN 0720	Porsche C20
Mid SAPS Fuel saving (reduced HTHS)	Mid SAPS	Low SAPS	Mid SAPS Fuel saving (heavily reduced HTHS)

Reduced HTHS = These oils may only be used in engines that are configured for them. Follow the manufacturer's instructions!

6.1 BMW

Approvals for BMW engines	
Longlife-98	Based on ACEA A3/B3, can be used from model year ´98 Invalid – is replaced by Longlife-01
Longlife-01	Based on ACEA A3/B4, can be used from model year ´01, for gasoline and diesel engines without DPF
Longlife-04	Based on ACEA C3, can be used from model year ´04
Longlife-12 FE	Based on ACEA C2, can be used from model year ´13, reduced HTHS viscosity, not backward compatible, only for selected engines
Longlife-14 FE+	Based on ACEA A1/B1, can be used from model year ´14, reduced HTHS viscosity, not backward compatible, only for selected engines

6.2 Fiat / Alfa Romeo / Lancia

Approvals for Fiat, Alfa Romeo and Lancia engines

9.55535-CR1	Based on ILSAC GF-5 or API SN, viscosity class 5W-20
9.55535-DS1	Based on ACEA C2, viscosity class 0W-30
9.55535-G1	Based on ACEA A1 or A5, viscosity class 5W-30, special development for CNG engines
9.55535-G2	Based on ACEA A3, viscosity classes 10W-40 and 15W-40, can be used in older gasoline engines
9.55535-GH2	Based on ACEA C3, viscosity class 5W-40, special development for "1750 turbo engine"
9.55535-GS1	Based on ACEA C2, viscosity class 0W-30, special development for 0.9 Twin Air (turbo) engine
9.55535-H2	Based on ACEA A3, viscosity class 5W-40, suitable for extended change intervals
9.55535-M2	Based on ACEA A3/B4, viscosity classes 0W/5W-40, suitable for extended change intervals
9.55535-N2	Based on ACEA A3/B4, viscosity class 5W-40, suitable for gasoline and diesel turbo engines
9.55535-S1	Based on ACEA C2, viscosity class 5W-30, suitable for gasoline and diesel turbo engines with WIV
9.55535-S2	Based on ACEA C3, viscosity class 5W-40, suitable for gasoline and diesel engines with WIV
9.55535-S3	Based on ACEA C3, viscosity class 5W-30, special development for Chrysler, Jeep and Lancia
9.55535-T2	Based on ACEA C3, viscosity class 5W-40, special development for gas engines
9.55535-Z2	Based on A3/B4, viscosity class 5W-40, special development for twin turbo diesel engines

6.3 Ford

Approvals for Ford engines	
WSS-M2C-913-A	Based on ACEA A1/B1
WSS-M2C-913-B	Based on ACEA A1/B1, backwards compatible with WSS-M2C-913-A
WSS-M2C-913-C	Based on ACEA A5/B5, backwards compatible with WSS-M2C-913-B
WSS-M2C-913-D	Based on ACEA A5/B5, replaces WSS-M2C-913-A, B and C
WSS-M2C-925-B	Based on API SM, backwards compatible with WSS-M2C-925-B, is replaced by WSS-M2C-948-B
WSS-M2C-917-A	Based on ACEA A3/B4, counterpart to VW 505 01
WSS-M2C-934-B	Based on ACEA C1, viscosity class 5W-30
WSS-M2C-948-B	Based on API SN, specially developed for Ford EcoBoost engines
WSS-M2C-950-A	Based on ACEA C2, specially developed for Euro 6 TDCi-engines, viscosity class 0W-30

6.4 Mercedes-Benz

Approvals for Mercedes-Benz engines	
MB-Approval 229.1	For all cars up to 03/2002, is replaced by MB 229.3
MB-Approval 229.3	For intervals up to 30,000 km, is replaced by MB 229.5
MB-Approval 229.5	Stricter requirements than with 229.3, intervals up to 40,000 km possible
MB-Approval 229.31	Requirements as with 229.3 but low-ash, is replaced by MB 229.51
MB-Approval 229.51	Requirements as with 229.5 but low-ash, is replaced by MB 229.52
MB-Approval 229.52	Increased requirements of oxidation stability and fuel saving
MB-Approval 226.5	Based on Renault RN0700
MB-Approval 226.51	Based on Renault RN0720
MB-Approval 229.6	Based on ACEA A5/B5, not backward compatible, only for selected engines
MB-Approval 229.71	Based on ACEA C5, not backward compatible, only for selected engines

6.5 Opel

Approvals for Opel engines	
GM LL-A-025	Based on ACEA A3/B3, specification for gasoline engines, is replaced by GM dexos2
GM LL-B-025	Based on ACEA A3/B4, specification for diesel engines, is replaced by GM dexos2
GM dexos2	Based on ACEA C3, applicable for all engines from model year ´10

6.6 Peugeot / Citroën

Approvals for Peugeot engines	
PSA B71 2290	Based on ACEA C3 with viscosity class 5W-30
PSA B71 2295	Based on ACEA A2/B2 for engines before model year 1998, no defined viscosity
PSA B71 2296	Based on ACEA A3/B4 with viscosity classes 0W-30, 0W-40, 5W-30 and 5W-40
PSA B71 2300	Based on ACEA A3/B4 with viscosity class xW-40, xW-50
PSA B71 2312	Based on ACEA C2 with viscosity class 0W-30

6.7 Porsche

Approvals for Porsche engines	
A 40	Based on ACEA A3 with viscosity classes 0W-40 and 5W-40, for gasoline engines from 1994
C 20	Based on ACEA C5, corresponds to VW 508 00/509 00, not backward compatible, only for selected engines
C 30	Based on ACEA C3, corresponds to VW 504 00/507 00

6.8 Renault

Approvals for Renault engines	
RN 0700	Based on ACEA A3/B4, permitted for all Renault gasoline engines
RN 0710	Based on ACEA A3/B4, permitted for all Renault diesel engines without a particulate filters
RN 0720	Based on ACEA C4, permitted for all Renault diesel engines with particulate filters from model year 2010

6.9 Volkswagen

Approvals for VW engines	
VW 500 00	Multi-grade oil with viscosity classes SAE 5W-X/10W-X, is replaced by VW 501 01
VW 501 01	Multi-grade oil with viscosity classes SAE 5W-X/10W-X, is replaced by VW 502 00
VW 502 00	Multi-grade oil for higher requirements
VW 503 00	Longlife specification for gasoline engines, based on ACEA A1, viscosity classes 0W-30/5W-30
VW 503 01	Longlife specification for supercharged gasoline engines, viscosity class 5W-30
VW 505 00	Multi-grade oil for vacuum and turbo diesel engines
VW 505 01	Multi-grade oil for unit injector engines, based on ACEA B4, viscosity class 5W-40
VW 506 00	Longlife specification for supercharged diesel engines, viscosity class 0W-30
VW 506 01	Longlife specification for unit injector engines
VW 504 00	Specification for gasoline engines with and without Longlife service, replaces all gasoline specifications listed above
VW 507 00	Specification for diesel engines with and without Longlife service, replaces all diesel specifications listed above (Except for R5 and V10 TDI engines before CW 22/06)
VW 508 00	Longlife IV-specification for gasoline engines with and without Longlife service, is not backward compatible, viscosity class SAE 0W-20
VW 509 00	Longlife IV-specification for diesel engines with and without Longlife service, is not backward compatible, viscosity class SAE 0W-20

COMMERCIAL VEHICLE SPECIFICATIONS

7. Commercial vehicle manufacturer specifications

Based on European vehicle manufacturers, the prescribed vehicle specifications are based on the engine tests of the ACEA or the API. In order to achieve a manufacturer approval for a certain oil, in addition to the respective ACEA/API test procedure, further engine tests and requirements must be fulfilled. An overview of which manufacturer specification is based on which ACEA/API classification can be found in the following graphic.

Standard SAPS	
MAN M 3277 MAN M 3377	MAN M 3275
Mercedes-Benz MB-Approval 228.5	Mercedes-Benz MB-Approval 228.3
Volvo VDS-3 Scania LDF-2 / LDF-3	Volvo VDS-3 Scania LDF-2 / LDF-3
API CI-4	API CI-4

E4	E7
Supercharged diesel engines up to Euro V under very difficult operating conditions, e.g. much longer oil change intervals	Supercharged diesel engines up to Euro V under difficult operating conditions, e.g. longer oil change intervals

DPF = diesel particulate filter,
SAPS = Sulfated Ash Phosphorus Sulfur

Mid SAPS

MAN M 3477 MAN M 3677	MAN M 3575
Mercedes-Benz MB-Approval 228.51	Mercedes-Benz MB-Approval 228.31
Volvo VDS-3 Scania LA-2	Volvo VDS-4
API CI-4	API CJ-4 API CK-4
DPF and sulfur-free fuel	DPF and sulfur-free fuel
E6	**E9**
Supercharged diesel engines up to Euro VI under very difficult operating conditions, e.g. much longer oil change intervals and exhaust gas aftertreatment	Supercharged diesel engines up to Euro VI under difficult operating conditions, e.g. longer oil change intervals and exhaust gas aftertreatment

7.1 Iveco

Approvals for Iveco engines	
18-1804 FE	Based on ACEA E4/E5 with TBN content >14
18-1804 TLS E6	Based on ACEA E6 with TBN content >13
18-1804 T2 E7	Based on ACEA E7 with TBN content >14
18-1804 TLS E9	Based on ACEA E9 or API CJ-4
18-1804 TFE	Based on ACEA E4/E7 with TBN content >16

7.2 MAN

Approvals for MAN engines	
M3275	SHPD motor oil, change interval of up to 60,000 km possible
M3277	UHPD motor oil, change interval of up to 80,000 km possible
M3377	Higher requirements of cleanliness/deposits than M3277, change interval according to display
M3477	Same as M3277 but low-ash for Euro 5 engines with DPF
M3677	Euro 6 engines with DPF, change interval up to 120,000 km possible

7.3 Mercedes-Benz

Approvals for Mercedes-Benz engines	
MB-Approval 228.1	Based on ACEA E2 + further engine tests
MB-Approval 228.3	Based on ACEA E7 + further engine tests
MB-Approval 228.5	Based on ACEA E4 + further engine tests, extended change interval
MB-Approval 228.31	Based on ACEA E9 + further engine tests, suitable for DPF
MB-Approval 228.51	Based on ACEA E6 + further engine tests, suitable for DPF, extended change interval
MB-Approval 228.61	Based on API FA-4 + further engine tests

7.4 Renault

Approvals for Renault engines	
RD/RD-2	Based on ACEA E3 + Volvo VDS-2
RLD/RLD-2	Based on ACEA E7 + Volvo VDS-3
RLD-3	Based on ACEA E9 + Volvo VDS-4
RXD	Based on ACEA E7 + Volvo VDS-3
RGD (Gas)	Based on ACEA E6 + Volvo VDS-3 + TBN >8

7.5 Scania

Approvals for Scania engines	
Scania LDF	Based on ACEA E5
Scania LDF-2	Based on ACEA E7 applicable from Euro 4
Scania LDF-3	Based on ACEA E7 applicable from Euro 6
Scania Low Ash	Basis ACEA E6/E9 (low-ash)

7.6 Volvo

Approvals for Volvo engines	
Volvo VDS	Based on API CD/CE, maintenance intervals up to 50,000 km possible
Volvo VDS-II	Based on ACEA E7, maintenance intervals up to 60,000 km possible
Volvo VDS-III	Based on ACEA E5, maintenance intervals up to 100,000 km possible
Volvo VDS-IV	Based on API CJ-4, short-distance, low-ash

MOTORBIKE SPECIFICATIONS

8. Motorbike manufacturer specifications

In motorbike engines the manufacturers largely forgo their own oil specifications and use the API or JASO determined engine tests for determining oil quality. In addition to determining the oil quality, for motorbikes that are equipped with clutches running in oil baths (wet clutch), higher requirements of shear stability, burning behavior and, above all, friction behavior have to be fulfilled. Whether an oil fulfills these properties can be found out via the JASO specification, which has to be listed under the approvals.

Approvals for motorbike engines by JASO

JASO MA/MA2	4-stroke engines – high friction value for motorbikes with wet clutches
JASO MB	4-stroke engines – low friction value for motorbikes without wet clutches
JASO FB	2-stroke engines – low cleaning, incomplete combustion
JASO FC	2-stroke engines – high cleaning, almost complete combustion
JASO FD	2-stroke engines – highest cleaning, complete combustion

GEAR OIL

9. Gear oil

To be able to ensure fault-free operation, modern transmissions require a modern high-performance lubricant that protects the transmission against wear and at the same time does not impair the shifting behavior. The type and quantity of the additives for the lubricant has a considerable influence on various parameters here, such as the shifting ability, the change intervals, the friction characteristics and the wear protection. It is therefore absolutely necessary that the specification or approvals stipulated by the manufacturer are complied with when changing the gear oil. With the number of transmission types on the rise, the gear oils have also been developed and adapted. There is an initial rough differentiation between manual or axle transmissions, automatic transmissions, dual-clutch transmissions and CVTs. Within these groups there are various sub-groups that all require a lubricant specially adapted to the design and application.

Note: In gear oils there is no uniform basis that the manufacturers are obliged to uphold (e.g. ACEA). This leads to a variety of special manufacturer approvals.

Examples:	
Mercedes-Benz:	
24 ATF approvals	(MB-Approval 236.x)
21 (Hypoid) gear oil approvals	(MB-Approval 235.x)
Volkswagen:	
14 ATF approvals	(G 052 xxx, G055 xxx, G060 xxx)
15 (Hypoid) gear oil approvals	(G 052 xxx, G055 xxx, G060 xxx)

9.1 Classification of gear oils

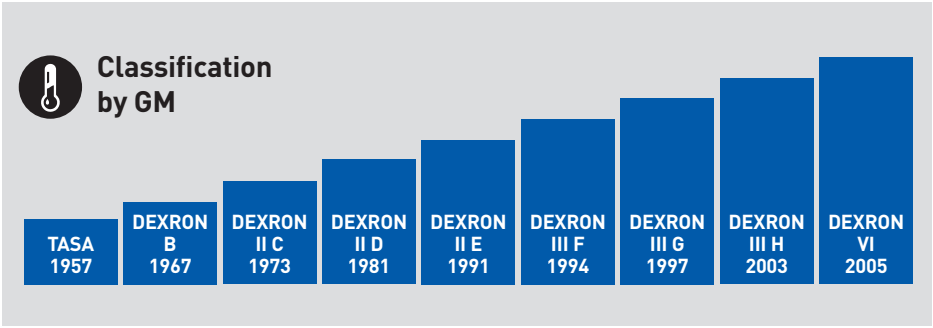
In order to at least be able to get a general answer as to what quality or which properties a gear oil corresponds to, over the course of the past few decades, division according to API became established for manual transmissions and axle drives and division according to Dexron became established for automatic transmissions. The manufacturers made use of this division over a long period of time.

After the transmission became ever more complex, however, this division was no longer sufficient. The viscosity of the manual transmission and axle drive is – as with motor oils – classified by SAE. The viscosity of automatic gear oils, so-called ATF oils (Automatic Transmission Fluid), is not classified by SAE, as the viscosity is a part of the respective manufacturer approval.

9.1.1 API (manual gear or axle drive oils)

GL 1	Low load hypoid transmission or worm gear
GL 2	Worm gear (not in road vehicles)
GL 3	Manual transmission (vintage)
GL 4	Manual transmission, hypoid transmission if permitted
GL 5	Hypoid transmission, manual transmission if permitted

9.1.2 GM Dexron (automatic transmission)



NOTES

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