BB00.40-P-0221-00A	Requirements of engine oils	Sheet 221.0	

MODEL ALL

Constant developments in combustion engines demand that engine oil too keeps pace with the technical status at any given time of the engines both in terms of its properties and performance. Engine oil is an important, decisive and integral design element for the function and service life of an engine and therefore it must comply with the technical quality standard of an engine. Engine oil is expected to fully fulfill its intended tasks, which extend well beyond the sole function of a lubricant, under all kinds of occurring operating conditions - at least until the scheduled oil change deadline.

The basic requirements placed on engine oils are initially specified verbally in the following list and not in the form of tests and limit values. The requirements are divided up into 8 topical areas. It is obvious that several requirements partly overlap or that they cannot be viewed independent of each other. The given sequence of requirements does not represent any form of priority. Depending on the engine model and the operating conditions the various points will have to have a different emphasis placed on them.

Area I - Friction and wear

1 Friction reduction

2 Fuel consumption reduction

3 Wear protection

4 Oil film tensile strength

5 No surface damage (pitting)

6 Preservation of honing pattern

7 Matching additive reaction temperature

8 Neutralization capability

9 Grip

Range II: temperature and viscosity

1 Thermal stability

2 Oxidation stability

3 Nitration resistance

4 High-temperature viscosity (shear rate, pressure)

5 Low-temperature viscosity (overflow, pumpability, continuous flow, no air inclusion)

6 Low temperature-dependent viscosity change

7 Viscosity stability (mechanical, thermal, oxidative)

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Range III: purity

1 Dispersing power

2 Detergency

3 No ring riding/no ring sticking

4 Prevention of hot sludge

5 Prevention of cold sludge

6 Prevention of paint

7 Resistance to water

8 Resistance to antifreeze with corrosion inhibitor

Range IV: no residues

1 No deposits on intake valves

2 No residue formation in combustion chamber

3 No glow ignition

4 No deposits in vicinity of turbochargers

Range V: oil/engine components

1 Corrosion protection

2 Compatibility with metals and paints

3 Compatibility with elastomers (seals)

4 Compatibility with filter materials

5 No blocking of filters

6 Thermal conductivity/cooling effect

7 Sealing capability

Range VI: Base oil/additives

1 Solubility of additives

2 Homogeneity

3 No filtering out of additives

4 No heat development

5 Prevention of foaming

6 Air emission capability

7 Low volatility/vaporization tendency

Range VII: application

1 Fuel consideration

2 Miscibility/compatibility

3 Running-in characteristics

4 Long change intervals

5 Applicability in different types of engine (manual transmissions, hydraulic systems)

6 Consistent quality
7 Inexpensive manufacture
8 Availability
9 Storage capability

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Area VIII: Environment

1 No negative effects on health and the environment
2 No negative effects on exhaust aftertreatment systems
3 No contribution to particulates
4 Does not emit odors
5 No disadvantages with regard to disposal and recycling

Explanations on the individual items in the areas

Area I - Friction and wear

1 **Friction reduction**

As with every lubricating oil, engine oil is obviously intended to prevent friction as far as is possible. A low engine friction horsepower contributes to improving efficiency; the output generated by the engine should primarily be available to propel the vehicle.

2 **Fuel consumption reduction**

Because the saving of energy has become the main focus of interest, engine oils must thus also play their part in helping to further reduce fuel consumption levels. A fuel consumption saving is possible, in particular during the warm up period, i.e. in the time between the cold start and reaching operating temperature. Through the choice of suitable additives it is now possible to exert a positive influence on friction-related conditions.

In the development and application of such oils, which are to be welcomed in principle, attention must however be paid to the fact that no disadvantages of any kind whatsoever arise, in particular in relation to the engine's service life. With regard to the individual car driver, the fleet owner and the national economy these oils must of course realize both financial and energy-related advantages. On no account should the fuel-consumption level rise.

3 **Wear protection**

In order to ensure that an engine achieves as high a mileage as possible without suffering any performance loss or increase in oil consumption, mechanical and corrosive wear must be prevented as far as is possible. This applies in particular to cylinder contact surfaces, pistons, piston rings and the valve timing (cams, tappets, cam followers or rocker arms, chains etc.). In many cases friction bearings are the limiting factor in the service life of an engine element, and for this reason they have to be especially protected against wear.

4 **Oil film tensile strength**

Even under the greatest of loads and at the highest of temperatures the oil film, e.g. between the piston ring and cylinder contact surface, must not break down, because direct metallic contact can lead to "seizure" and thus to a total loss.

5 **No surface damage**

The engine oils must protect all components from any surface damage and should not cause any such damage themselves. This applies in particular to pittings on tappets, which can lead to damaging the cams.

6 **Preservation of honing pattern**

A well preserved honing pattern on the cylinder contact surface is essential for ensuring a controlled oil consumption. For this reason "bore polishing" or "deposits" must not occur. This is absolutely essential for a long service life.

7 **Matching additive reaction temperature**

The oil additives used for protection against wear do not achieve this solely on account of their presence, but rather through a chemical reaction on the surface of the components.

Therefore, one has to make sure that the reaction temperatures of the additives match those operating temperatures (and pressures), e. g. that are prevalent on the cams.

8 **Neutralization capability**

Gasoline fuels and, in particular, diesel fuels contain sulfur. During combustion of this sulfur content the fuel may give off sulfurous acids or sulfuric acid together with combustion water. This must on no account take place, and therefore such acids must always be immediately neutralized.

Engine oil must also be alkaline; this alkalinity is partially reduced during the neutralization process, however a certain residual alkalinity must be retained until the next oil change is due.

9 **Grip**

If the engine is switched off during full-load operation at a high temperature, a residual oil film must remain at the lubricating points, so that a subsequent start-off in a cold condition does not lead to damage as a result of "running dry".

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Area II - Temperature and viscosity

1 **Thermal stability**

Engine oil must exhibit thermal stability at whatever temperature; it must not alter in an unfavorable way.

2 **Oxidation stability**

Because oxygen is always present as a result of the high temperatures in the engine compartment, the oil must be oxidation resistant; it must not lose its advantageous properties and not form any natural oil oxidation products or residue. This would lead to a rise in the oil's acidity level and to the oil thickening. Thickening oil causes problems when cold-starting and increases the fuel-consumption level.

3 **Nitration resistance**

During combustion, nitrogen oxide is formed, which acts upon the oil together with the blow-by gases. This in turn can lead to a nitration with subsequent sludge formation. Ever since the arrival of the "oil-sludge problems" one is aware of how important nitration resistance is.

4 **High-temperature viscosity**

To preserve the minimum lubricating film that is absolutely essential at high loads, it is necessary to have sufficient viscosity during these high temperatures. When specifying this minimum viscosity the factors of shear rate and pressure conditions that are prevalent at the lubricating points must also be taken into account alongside that of temperature

5 **Low-temperature viscosity**

Engine oil is called upon to play a vital contribution when starting and warming up the engine at low temperatures. In this context several, independent of each other, procedures must be heeded.

First of all, the oil's internal friction must not be too large, so that the crankshaft and the other engine components can break free and rotate or move. The oil must be pumpable, i.e. the oil pump must be able to draw it in and deliver it. In doing so the pump must at no time run idle; the oil must flow from the pan to the sieve to the pump. Air must not be locked in. This helps to support the engine being turned over and the bearing points having oil applied to them immediately (excellent flow behavior, lubrication of the engine).

6 **Low temperature-dependent viscosity change**

The viscosity specifications at high and low temperatures, which directly oppose the physical characteristics of the oil, result from the necessity to keep the temperature-dependent viscosity changes as few as possible. Engine oils should be able to be used regardless of the particular season of the year and the outside temperature.

7 **Viscosity stability**

Multigrade oils are capable of fulfilling the low temperature-dependent viscosity changes. If however, these are produced with viscosity index improvers, then care should be taken to ensure that these exhibit mechanical, thermal and oxidative shear resistance. This means that the viscosity of fresh oil should be retained for as long as possible and should not be depleted before the scheduled oil change interval is reached.

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Area III - Cleanliness

1 **Dispersing power**

The insoluble oil residue which is generated during the combustion process and the natural oil residue have to be dispersed and suspended; they must not coagulate and deposit themselves on the engine components, this applies to both particularly hot and cold positions.

2 **Detergency**

Engine oil must be capable of "washing away" previously deposited sediments to a certain extent and thus achieve a cleansing effect.

3 **No ring riding/no ring sticking**

Combustion and oil residue, which cannot be borne by the oil, tends to deposit itself in the piston ring grooves, because this is where extremely high temperatures occur. Here however, the piston rings which play a significant role in the engine's operation, can be impaired in their tasks. The piston rings must be free to move at all times.

Deposits on the base of the ring groove or on the back of the ring must not be so strong that the ring tends to "ride"; deposits on the ring or groove sides must not cause ring sticking to occur. Riding or sticking rings lead to a power loss, increased oil consumption, ring/cylinder scuffing and to engine failure as a result.

4 **Prevention of hot sludge**

The formation of sludge should also be prevented at the highest occurring temperatures under all conditions. In particular this should be observed for diesel fuel engines. If the oil pump is forced to breathe in sludge the lubrication of the engine (oil supply/protection against wear) can no longer be guaranteed.

Beyond this, sludge is not only a blemish, it also hampers any maintenance work to be conducted on the engine, as well as draining oil and carrying out an oil-level check.

5 **Prevention of cold sludge**

Applies mainly to gasoline engines, but diesel engines that are frequently driven over short distances are also affected and therefore it is necessary that the formation of cold sludge is prevented. Its formation is greatly favored by the presence of condensed water and fuel residue as well as any failure to reach the regular operating temperature.

6 **Prevention of paint**

Paint, which primarily occurs in gasoline engines after running at high temperatures is also to be prevented where possible.

Paint coats, that exceed specific limits, will impair the operation of engine components. Paint also hampers the heat transfer, heat dissipation is poorer and excessive temperatures are the result.

7 **Resistance to water**

Condensed water can form at any time and anywhere and succeed in entering the engine oil. This must not be impaired in its quality and function in any way.

8 **Resistance to antifreeze with corrosion inhibitor**

Coolant (water and antifreeze with corrosion inhibitor) occurs only rarely in engine oil, however in the majority of such cases this can ruin the engine oil and cause sludge to be formed in the engine.

A greater resistance of the engine oil to water and antifreeze with corrosion inhibitor is highly desirable.

Area IV - No residue

1 **No deposits on intake valves**

Deposits on intake valves cause engines, that in terms of emissions and fuel consumption are ideally set, to malfunction during operation, particularly during the warm-up phase. Although fuel does indeed exert an essential influence it is important to ensure that the engine oil formula does not enable the oil to contribute in any way to the formation of deposits.

2 **No residue formation in combustion chamber**

A certain minimum amount of engine oil is also burnt in the combustion chamber, this must not however generate any residue or deposits. In direct-injection diesel engines the distances between the underside of the valve disk and the top of the piston base is extremely small at specific crankshaft positions. On no account may contact take place as a consequence of any residue or deposits.

3 **No glow ignition**

When residue is formed in the combustion chamber of a gasoline engine, it can have an affect similar to a glow plug and cause advance ignition and piston scorching. This must be prevented.

4 **No deposits in vicinity of turbochargers**

Extremely high temperatures can occur close to turbochargers, particularly after switching off the engine. Here and in the entire charge-air cooling system there should be no formation of deposits.

Area V - Oils/engine components

1 **Corrosion protection**

All metallic engine components must be reliably protected against corrosion, this must also include long service life periods. This requirement applies to all engine oils, in particular of course for break-in engine oils.

2 **Compatibility with metals and paints**

It goes without saying that engine oils must be compatible with all the various metals that are present in the engine construction and that they are in no way impaired. There have however been no problems in this area for a long time.

The engine oil must also be absolutely compatible with all paints used for the body paintwork, i. e., such paints must not be impaired in any way. Occasionally engine components are also painted on the inside, e. g. the crankcase. These paints too must not be aggravated in any way by the engine oil.

3 **Compatibility with elastomers (seals)**

Similar requirements regarding compatibility with the elastomers (seals) are also essential factors; the engines must be absolutely tight and remain so. Even the finest engine oil is useless if it does not remain in the engine; leaking oil is never a pleasant sight and is nothing less than environmental contamination. Seals must not shrink or become brittle and crack under the influence of the oil, a slight swelling is normally tolerated. The resistance properties must remain intact. When a new engine oil comes onto the market it must be compatible with all the seals that are installed in the engine.

4 **Compatibility with filter materials**

Primary and bypass filters or their inserts are made of different materials, e. g. high-grade paper or stuffed cotton. Engine oil must be compatible with all these different materials and provide a trouble-free filtration.

5 **No blocking of filters**

Naturally, the engine oil itself, and in particular the additives in it, must not lead to the filter being plugged up (increase in differential pressure).

6 **Thermal conductivity/cooling effect**

It is the task of engine oil to cool the engine components which are the most highly stressed from a temperature point of view, i.e. to dissipate the heat. Obviously the temperature level in the engine is highly dependent on the engine design and operating conditions. Only when the component and oil temperatures do not exceed a reasonable value, is it possible to guarantee a long service life for the engine. To this end the engine oil must fulfill its role as a heat-transfer oil.

7 **Sealing capability**

Where possible a complete and faultless sealing between the combustion chamber and the engine compartment is a significant precondition for ensuring high degree of engine efficiency. Engine oil must support the piston rings in this task.

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Area VI - Basic oils/additives

1 **Solubility of additives**

All additives used in the production of engine oil must be capable of being completely dissolved in the basic oil and remaining so.

2 **Homogeneity**

The engine oil must be absolutely homogeneous, even if stored in large containers over a longer period of time and if it has been refilled frequently.

3 **No filtering out of additives**

Several of the previously mentioned points make it inevitable that the applied additive may not be filtered out.

4 **No heat development**

The additives do not work solely on account of their presence, but rather their chemical conversion. As little heat as possible should be generated by this process.

5 **Prevention of foaming**

Oil is subjected to very turbulent motion in the crankcase; this gives rise to the possibility of air intake, particularly at very high engine speeds. However, this air intake must be as low as possible in order to prevent any substantial foaming. Oil foam can naturally not form the required lubricating film; as a result wear damage occurs. Similarly, the hydraulic valve-clearance compensation is also impaired, with the result that undesirable noise is heard when the gas content is too high.

6 **Air emission capability**

However if foam has already formed, the entrained air must be released again immediately, i.e. the entrained air must not be retained.

7 **Low volatility/vaporization tendency**

All combustion engines have a certain degree of oil consumption. As a result the necessity to top up with fresh oil also represents an advantage in terms of the qualitative status of the oil replenishment and consequentially with regard to the wear protection and the cleanliness of the engine. However, no natural oil consumption, dependent on the oil composition, may take place solely on account of the high temperatures. The volatility, i.e. the tendency of the oils to volatize must be therefore be low. This is particularly important with regard to basic oils or basic oil components (multigrade oils) with low viscosity.

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Area VII - Application

1 **Fuel consideration**

The fuel has a considerable influence on the engine oil. This is not just a matter of the different levels of sulfur content in diesel and gasoline fuels. The use of unfavorable and poorly combustible diesel fuel qualities results in a considerable amount of combustion residue in the engine oil.

Nonburned fuel residue reduces the viscosity of the oil. Fuel additives can impair the function of oil additives. Nonburned fuel additives make their way into the engine oil.

Other fuels, such as methanol or plant oil methyl ester can demand modified engine oils. Flexible engines that have been designed to cope with several types of fuel, should also be supplied with corresponding engine oils, that are suitable for all kinds of fuel and mixtures. The suitability of engine oils must be checked completely for all alternative fuels.

2 **Miscibility/compatibility**

Engine oils, even if from various producers and different SAE areas, must be mixable and absolutely compatible. This also applies to all products that are intended for the same purpose, regardless of whether they, e.g. are based on synthetic or mineral basic oils. Decisive is whether the mixture fulfills all the tasks placed on the engine oil in every mixture ratio. A reference to miscibility on its own is therefore not sufficient.

However its is also obvious that mixtures cannot always be as good as non-mixed oils with regard to all the criteria. Certain losses in terms of viscosity temperature behavior and performance cannot be ruled out.

3 **Running-in characteristics**

Those engine oils that are used for new or reconditioned engines must, alongside their other tasks, also accelerate the running-in characteristic or at least make it possible.

4 **Long change intervals**

Oil changes not only cost time and money, but also represent a major organizational task where large fleets are concerned. During the necessary stand-down times the vehicle is not capable of fulfilling its transportation tasks. For this reason, there is now a call for engine oil to not only fully fulfill all of its tasks when new or after only a few thousand driven kilometers, but for it to also do so over as long a period of operation as possible. A "lifetime filling" however still remains an illusion.

5 **Applicability in different types of engine (manual transmissions, hydraulic systems)**

The idea of developing an optimum oil for each different kind of engine, is only a positive notion at first glance, this applies even to running-in oils. It is much more appropriate, to cater for as many of the various types of engine on the market with as few engine oil versions as possible and to do so not only adequately, but also without any associated problems.

With the great diversity of motor vehicles, resulting from the different requirements placed on these vehicles and from their competitive situations, there are of course a great deal of engine models present that have to be supplied with only a few different oil grades. It is not only the commercial and logistical reasons that compel oil grades to be kept to a minimum, but also the clarity required by both service and workshop operations. The fewer oil grades that are available, the less the danger of getting them mixed up.

In addition to their use in engines there are certain cases where there is also need to use engine oils in manual transmission and hydraulic systems.

6 **Consistent quality**

It is not enough if the demands posed can only be fulfilled by samples manufactured under laboratory conditions. Industrial production or manufactured products must comply with all demands. This is of course only possible with extremely constant production methods. Unavoidable production tolerances must not lead to any losses of quality. The finest development is worthless if it cannot be produced constantly in the desired quantities.

7 **Inexpensive manufacture**

The optimum engine oil formulation must also undergo inspection as to whether it can indeed be manufactured inexpensively. There must be an appropriate relationship between price and quality.

8 **Availability**

Engine oils approved by MB should be available worldwide if possible. This particularly applies to the so-called Low SPAsh oils necessary for vehicles with diesel particulate filter.

9 **Storage capability**

On the condition that storage has taken place properly, i.e. good container, no ingress of contaminants and water, practically unlimited shelf life is to be claimed.

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Area VIII - Environment

1 **No negative effects on health and the environment**

The health and environment area is naturally a factor of major importance. With regard to manufacture, use and disposal, special care must be taken to ensure that there are no detrimental effects on health and environment.

2 **No negative effects on exhaust aftertreatment systems (particulate filters, three way catalytic converters and oxygen sensors)**

Exhaust aftertreatment systems for reducing the emissions of gasoline engines such as the oxygen sensor and the three-way catalytic converter must not be detrimentally affected by engine oils or the combustion products thereof. In modern diesel engines, exhaust aftertreatment systems, such as e.g particulate or soot filters, CRT, SCR systems, etc. may not be negatively influenced by basic oil components and additives of the engine oil. Likewise the oil consumption should therefore not increase.

3 **No contribution to particulates**

Further developments in diesel engines are geared towards major efforts being undertaken to ensure that the level of particulates is significantly reduced. Because a significant portion of these particulates originates from oil, oil-consumption levels have been successfully cut back in recent years. However, the basic oil components and additives still require to be analyzed and optimized in terms of bringing about further particulate reductions.

4 **Does not emit odors**

Engine oils must not emit any unpleasant odors even at high temperatures. In this context, consideration should be given to drivers and passengers as well as the people who work in factories, workshops and warehouses.

5 **No disadvantages with regard to disposal and recycling**

Until such time as lifetime oil is available oil will always need to be changed. Naturally, it is sensible to drain off this oil, collect it and to convey it to a reputable recycling plant. Right back at the initial conception of the engine oil, consideration must be given to ensuring that no problems will arise later on when it needs to be disposed off or recycled.

Engine-oil tests

For the evaluation of engine oil quality there are both absolute dimensional units and comparative assessments and judgments. The fastest and most economical method of testing is that of a chemical-physical analysis conducted in the laboratory. Laboratory analysis enables several important properties to be determined, e.g. viscosity, alkalinity, sulfate ash content, corrosion behavior, etc.; however, for the purpose of a final quality evaluation, tests must be conducted in specific test machines and engines. For these tests there are a number of methods and test equipment available which enable one or at the same time several characteristics in the engine oil to be analyzed.

The following test equipment is used in the appraisal of engine oils:

- Testing machines with simple components
- Test units for inspecting oil on individual engine components
- Single-cylinder engines on test bench
- Multiple-cylinder engines on test bench
- Engines in operation

Because of the fact that these test methods differ significantly in outlay, the tests are conducted as each situation demands.

With regard to the overall assessment of an engine oil various countries and many different institutions have compiled specifications comprising of a series of test methods.

The best known internationally are the classifications of the American Petroleum Institute (API, information on the Internet under www.api.org), as well as the test sequences of the European automotive manufacturers ACEA (ACEA = Association des Constructeurs Europeéns de LAutomobile; information on the Internet under www.acea.be). The ACEA test sequences were presented for the first time in December 1995. As of January 1st 1996, these ACEA test sequences replaced the CCMC test sequences valid until then.

In the Mercedes-Benz engine oil specifications listed on the following pages the ACEA test sequences are taken into account as basic requirements. However, to some extent our requirements for modern engine oils in the Mercedes-Benz engine oil specifications go significantly beyond the requirements in the ACEA test sequences.

Due to the needs of current and future production engines, such as extension of oil change intervals, greater fuel saving, lower wear, better engine cleanliness, further reduction in emissions, better environmental compatibility and many more, a higher performance from the engine oils is required. In other words, in the Mercedes-Benz engine oil specifications more tests or additional test criteria and to some extent more stringent limits are required than those by the ACEA in order to achieve the objectives stated.

Break-in engine oils

Break-in engine oils are suitable for running in and continued operation of engines beyond the prescribed maximum mileage or service life. They are likewise used for function test and preservation of engines.

They are charged with the task of exerting a favorable influence on the engine's running-in process. In addition to this they must have good corrosion protection. They must be capable of protecting the inside of the engine against corrosion even at high humidity conditions (sea or tropical climates), of bonding small quantities of condensed water, or preventing it from coming into contact with the metal and of neutralizing the acidic combustion and aging products in the engine. Sufficient additives must be used in order to prevent or reduce wear, deposits, sludge, aging (oxidation) and in order to further reduce the fuel consumption of the engines. When using these oils no disadvantageous changes are allowed to occur to the engine.

An overview of which break-in engine oil is allowed to be used with which engine is available on Sheet 223.1.

Sheet 225.5 (Multigrade oils SAE 15W-40)

These break-in engine oils are only approved in exceptional cases for older diesel engines in model series 300 and model series 400 for oil distances of up to a maximum of 5000 km and oil operating periods of up to a maximum of 100 h. They have been replaced by the break-in engine oils described in Sheets 225.6 and 225.12. The break-in engine oils described in Sheet 225.5 may be used in exceptional cases only, if no other approved break-in engine oil is available! For use, see sheet 223.1.

Sheet 225.6 (Multigrade oils SAE 10W-40 and SAE 5W-30)

Break-in engine oils in accordance with Sheet 225.6 are approved for specific diesel engines model series 300, model series 400, model series 500, (model series 600), model series 900 for oil change intervals up to a maximum of 100,000 km (vehicle-specific, in line with the maintenance booklet) or up to a maximum of 2000 h. For use, see sheet 223.1.

Sheet 225.8 (Multigrade oils SAE 10W-40)

Break-in engine oils in accordance with Sheet 225.8 are only approved for certain older engines in model series 100, model series 600 (see Sheet 223.1) for oil change intervals up to a maximum of 15,000 km (without ASSYST)/30,000 km (with ASSYST) or up to a maximum of 300 h.

They are currently gradually being replaced by break-in engine oils as per Sheets 225.10, 225.11 and 225.12.

For use, see sheet 223.1.

Sheet 225.10 (Multigrade oils SAE 5W-30)

Break-in engine oils in accordance with Sheet 225.10 are approved for specific passenger car engines in the model series 100, model series 200 and model series 600.

Exceptions to this are engines in vehicles equipped with a diesel particulate filter, in AMG vehicles or certain older engines.

For use, see sheet 223.1.

Compared with Sheet 225.8 these engine oils exhibit the following features:

- Higher quality with regard to wear and cleanliness
- Better cold-starting properties
- Further improved fuel saving potential
- Potential for longer oil change intervals (in combination with new oil filter elements)
- Better environmental compatibility

Sheet 225.11 (multigrade oils SAE 5W-30) with low sulfur content, low phosphor content and low content of ash-forming components - "Low SPAsh oils"

These "Low SPAsh" break-in engine oils are approved for passenger car diesel engines in model series 600 or passenger car diesel vehicles that are equipped with a diesel particulate filter.

For use, see sheet 223.1.

Compared with Sheet 225.8 these engine oils exhibit the following features:

- Higher quality with regard to wear and cleanliness
- Better cold-starting properties
- Further improved fuel saving potential
- Better environmental compatibility.

Compared with Sheet 225.10 these engine oils are distinguished by the following:

- Better environmental compatibility
- Better compatibility with exhaust aftertreatment systems, e.g. diesel particulate filters by having a lower sulfur content, lower phosphor content and lower content of ash-forming components.

Specification 225.11 is replaced for certain diesel engine model series by the new Specification 225.17. Additional information on these Low SPAsh oils is available in the description in Sheet 229.31 and 229.51.

Sheet 225.12 (Multigrade oils SAE 10W-40 with low sulfur content, low phosphor content and a lower content of ash-forming components - "Low SPAsh oils")

"Low SPAsh" break-in engine oils from Sheet 225.12 (or Sheet 228.51) currently represent the highest oil grade with low sulfur content, low phosphor content and low ash-forming component content (low ash) for commercial vehicle diesel engines. "Low SPAsh" break-in engine oils SAE 10W-40 are currently only approved for selected commercial vehicle diesel engines that are equipped with particulate filter systems such as DPF and CRT.

For use, see sheet 223.1.

Additional information on the "Low SPAsh" break-in engine oils in accordance with Sheet 225.12 is available in the description Sheet 228.51 ("Low SPAsh" engine oils for oil service). Specification 225.12 is replaced for certain commercial vehicle diesel engine model series by the new Specification 225.18.

In all cases, the oil change specifications, as specified in the maintenance booklet for the respective vehicle, apply.

Additional information can be found in the maintenance procedures.

Engine oils (Service)

These engine oils are for service purposes, in other words for the continued operation of engines after the first oil change and for all subsequent oil changes. There are service engine oils for individual engine types (e.g. only for gas engines, for all diesel with and without diesel particulate filters, but also universal oils for passenger car gasoline and passenger car diesel engines) in several grades. Generally, the higher the oil quality, the longer the oil change intervals can be.

An overview of which engine oil is allowed to be used with which engine for an oil service is available on Sheet 223.2.

Engine oils (service) for commercial vehicle gaseous fuel engines and industrial engines (gaseous fuel) from commercial vehicle area Sheet 226.9 (Multigrade oils)

Engine oils as under Specification 226.9 have been approved for all stationary and non-stationary commercial vehicle natural-gas engines based on BR 300, 400 and BR 900 (e.g. also applies to CNG buses).

These engine oils are subject to certain requirements that are specifically geared towards natural-gas engines. These oils are not approved for gasoline and diesel engines.

For use, see sheet 223.2.

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Engine oils (Service) for all commercial vehicle and passenger car diesel engines and industrial engines (diesel) from the commercial vehicle and passenger car range (model series 300, model series 400, model series 500, model series 600, model series 900)

These engine oils can be used as a continued operation oil in certain Mercedes-Benz diesel engines. These oils are not approved for gasoline-fuel engines!

Sheet 228.0 (Single grade oils) and Sheet 228.1 (Multigrade oils)

Engine oils as per Sheet 228.0/.1 are approved for certain diesel engines. The basic requirements of ACEA E2. apply to these engine oils. Additional Daimler AG requirements also apply.

For use, see sheet 223.2.

Sheet 228.2 (Single grade oils) and Sheet 228.3 (Multigrade oils)

Engine oils as per Sheet 228.2/.3 are approved for certain diesel engines. The basic requirements of ACEA E7 (previously ACEA E3 or E5) apply to these engine oils. Beyond this are the more comprehensive specifications of Daimler AG.

For use, see sheet 223.2.

Sheet 228.31 (multigrade oils with low sulfur content, low phosphor content and low content of ash-forming components - "Low SPAsh oils")

"Low SPAsh" engine oils as per sheet 228.31 are only specified for certain diesel engines at this time.

For use, see Sheet 223.2.

What is Sheet 228.31?

- A commercial vehicle engine specification for "Low SPAsh" engine oils at medium performance level (equivalent to performance capability of Sheet 228.3).
- An engine oil specification, which is geared (as was Sheet 228.51) to excellent compatibility with exhaust aftertreatment systems, such as diesel particulate filter (DPF) and three-way catalytic converters for NOx reduction (SCR).

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What are the backgrounds for the introduction of Sheet 228.31?

- Future common Heavy Duty Engine Platform (HDEP) in North America and Europe with similar demands with regard to engine oil performance.
- The specification of Sheet 228.31 corresponds to the common understanding of Mercedes-Benz (MB) and Detroit Diesel (DDC), with regard to engine oil requirements that are necessary for complying with the emission standards in the USA (EPA 2007) and Europe (Euro 5).
- This new engine oil specification should simultaneously improve the acceptance and availability of "Low SPAsh" engine oils and do so specifically for the American market.
- Oils on Sheet 228.31 represent a low-cost alternative for customers to the previously available oils on Sheet 228.51.

- Harmonization of Daimler-internal European and American oil specifications (based on ACEA & API) - first global commercial vehicle engine oil specification for HDD (GEOS HD 1).

What are the most important requirements and tests for a release as far as sheet 228.31 is concerned?

- Basic performance: API CJ-4 and tests as per Sheet 228.3 (equiv. performance level of ACEA E7) + Daimler-specific requirements:
- Laboratory tests: Sulfated ash <1.0 % by weight,

Sulfur <0.40 % by weight,

Phosphor <0.12 % by weight,

TBN (neutralization capability)

<7.0 mg KOH/g

MB sealing tests

Pass acc. 228.31 limits = DB supply specification 6610

- Engine tests: OM 646 DE 22 LA Test

Pass acc. 228.31 limits

OM 501 LA EURO 5 Test

Pass acc. 228.31 limits

Sheet 228.5 (Multigrade oils)

Engine oils in accordance with Sheet 228.5 are approved for certain diesel engines (see Sheet 223.2) and we highly recommend them. These low-friction engine oils enable commercial-vehicle diesel engines to have the longest oil-change intervals. These engine oils currently represent the highest grade for commercial vehicle diesel engines. The basic requirements of ACEA E4. apply to these engine oils. Additional Daimler AG requirements also apply.

For use, see sheet 223.2.

Sheet 228.51 (Multigrade oils with low sulfur content, low phosphor content and low content of ash-forming components - "Low SPAsh oils")

"Low SPAsh" engine oils as per Sheet 228.51 are approved for specific diesel engines. These "Low SPAsh" engine oils currently represent the highest oil grade with low sulfur content, low phosphor content and low ash-forming component content (low ash) for diesel engines. The basic requirements of ACEA E6. apply to these engine oils. Additional Daimler AG requirements also apply.

For use, see sheet 223.2.

Engine oils (service) for

Passenger vehicle engines (BR 100, BR 200, BR 600),

Commercial vehicle engines from the passenger vehicle sector (BR 100, BR 200, BR 600) and

Industrial engines from the PC sector (model series 100, 200, 600)

The engine oils on Sheets 229.1, 229.3, 229.31, 229.5 and 229.51 can be used as continued operation oils (service engine oils for the oil service) depending on quality and use in certain Mercedes-Benz passenger car engines.

These oils are **not** approved for commercial vehicle diesel engines model series 300, model series 400, model series 500, model series 900!

General

In 1997, Daimler AG introduced a new approval system for passenger car engine oils, which has been considerably expanded compared to the earlier approval procedure and demands detailed documentation of the oil quality. The specifications for Sheets 229.1, 229.3, 229.31, 229.5 and 229.51 on the ACEA test sequences (first introduced on 1.1.1996), cover much more than just this with regard to the requirements.

This MB approval system for passenger car engine oils has been consistently further developed since its introduction.

Today, our customers have an adequate choice of options with the engine oils on sheets 229.1, 229.3, 229.31, 229.5 and 229.51 of the Mercedes-Benz Specifications for Operating Fluids so that they can decide for themselves on a particular quality level and an optimum engine oil for their operating conditions.

The use of Sheets 229.1, 229.3, 229.31, 229.5 and 229.51 in certain passenger car gasoline engines and diesel engines (model series 100, model series 200, model series 600) is explained in greater detail in Sheet 223.2.

Which engine or which vehicle can use which oil quality over which oil change interval is also listed in the constantly updated Service Information for passenger cars: "Engine oil change" SI18.00-P-0011A.

The maintenance procedures that have been individually defined for each vehicle model apply in all cases.

Sheet 229.1 (Multigrade oils)

These engine oils are only approved for certain passenger car engines (model series 100, model series 200, model series 600), commercial vehicle engines from the passenger car range (model series 100, model series 200, model series 600) and industrial engines from the passenger car range (model series 100, model series 200, model series 600). For use, see sheet 223.2.

For these engine oils the basic requirements as per ACEA A3-04 or B3-04 apply. In addition, there are other specific requirements from Daimler AG.

Sheet 229.3 (Multigrade oils)

These low-friction engine oils are approved for certain passenger car engines (model series 100, model series 200, model series 600), commercial vehicle engines from the passenger car range (model series 100, model series 200, model series 600) and industrial engines from the passenger car range (model series 100, model series 200, model series 600).

For use, see sheet 223.2.

Approvals are also possible for low-friction engine oils in SAE grades 0W-X, 5W-X and 10W-X. The basic requirements of ACEA A3-04 and B4-04 apply to these engine oils. Beyond this are the more comprehensive specifications of Daimler AG.

Compared with Sheet 229.1 these engine oils exhibit the following features:

- higher quality (with regard to wear and cleanliness)
- fuel saving potential
- better cold-starting properties
- better environmental compatibility (reduced chlorine and sulfur content)

Sheet 229.31 (multigrade oils with low sulfur content, low phosphor content and low content of ash-forming components - "Low SPAsh oils")

These "Low SPAsh" low-friction engine oils are approved for certain passenger car engines (model series 100, model series 200, model series 600), commercial vehicle engines from the passenger car range (model series 100, model series 200, model series 600) and industrial engines from the passenger car range (model series 100, model series 200, model series 600).

For passenger car diesel engines or passenger car diesel vehicles that are equipped with a diesel particulate filter, these Low SPAsh engine oils on Sheet 229.31 are compulsory!

For use, see sheet 223.2.

Approvals are only possible for low-friction engine oils that comply with the low limits with regard to sulfur, phosphor content and the content of ash-forming components. The basic requirements of ACEA A3-04, B4-04 and C3-04 apply to these engine oils. Beyond this are the more comprehensive specifications of Daimler AG.

Compared with oils from Sheet 229.1/ 229.3 / 229.5 these engine oils excel on account of their lower sulfur content, lower phosphor content and lower content of ash forming constituents. This means improved compatibility with exhaust aftertreatment systems such as diesel particulate filters.

Compared with oils from Sheet 229.1 these oils also excel on account of:

- improved environmental compatibility (reduced chlorine, sulfur and phosphor content)
- higher quality (with regard to wear and cleanliness)
- fuel saving potential
- Better cold-starting properties.

Sheet 229.5 (multigrade oils)

These low-viscosity engine oils are approved for specific passenger car engines

(model series 100, model series 200, model series 600), commercial vehicle engines from the passenger car range

(model series 100, model series 200, model series 600) and industrial engines from passenger car range (model series 100, model series 200, model series 600).

For use, see sheet 223.2.

The basic requirements of ACEA A3-04 and B4-04 apply to these engine oils. Beyond this are the more comprehensive specifications of Daimler AG.

Compared with Sheet 229.1 and 229.3 the engine oils are characterized by:

- highest quality (with regard to wear and cleanliness) for approved passenger car engine oils
- even further improved fuel saving potential
- potential for even longer oil change intervals (in combination with new oil filter elements)

- further improved environmental compatibility

Sheet 229.51 (multigrade oils with low sulfur content, low phosphor content and low content of ash-forming components - "Low SPAsh oils")

Now that the 1st generation of "Low SPAsh" low-friction engine oils has been successfully introduced in MB diesel passenger cars with diesel particulate filters with sheet 229.31, the progress in the additive and mineral oil industry should be taken into account and a new "Low SPAsh" oil specification introduced at the highest performance level.

What is sheet 229.51?

Sheet 229.51 is a passenger car engine oil specification for "Low SPAsh" low-friction engine oils at the highest performance level (2nd generation "Low SPAsh" low-friction engine oils, with the performance capability as described in Sheet 229.5), i.e. with the most stringent limits in terms of wear and cleanliness.

These oils are outstanding because they provide the best possible protection from black sludge formation and deposits. They also have improved fuel saving potential (fuel economy benefit in the M111 FE test CEC SG-L54 > 1.7 % = Sheet 229.5 level) coupled with an improved environmental compatibility.

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What are the most important requirements and tests for a release as far as sheet 229.51 is concerned?

Laboratory tests: Sulfur < 0.30 % by weight,

Phosphor 0.05 - 0.09 % by weight,

Sulfated ash <0.8 % by weight.,

Chlorine < 0.015 % by weight,

TBN (neutralization capacity) > 6.0 mg KOH/g

Engine test:

M 271 Wear test pass acc. 229.51 limits

M 271 Sludge test pass acc. 229.51 limits

M 111 Fuel economy test pass acc. 229.51 limits (>1.7 %)

OM 646 DE22LA test pass acc. 229.51 limits

Plus other ACEA and OEM tests: Pass ACEA A3, B4, C3, VW TDI,VW T4, ...

The basic requirements of ACEA test sequences A3-04, B4-04 and C3-04 apply to these engine oils. Beyond this are the more comprehensive specifications of Daimler AG. Approvals are only possible for low-friction engine oils that comply with the low limits with regard to sulfur, phosphor content and the content of ash-forming components. The detailed requirements for an approval of these high-performance engine oils are listed in the table "Mercedes-Benz specifications for engine oils (service fill)".

Compared with oils from Sheet 229.1/229.3/229.5, these engine oils are distinguished by their lower sulfur content, lower phosphor content and lower content of ash-forming components. This means improved compatibility with exhaust aftertreatment systems such as diesel particulate filters.

Compared with oils from Sheet 229.1/229.3 these engine oils are also distinguished by the following:

- Improved environmental compatibility (reduced chlorine, sulfur and phosphor content)
- Higher quality (with regard to wear and cleanliness)
- Better fuel-saving potential.

Viscosity of service engine oils

Apart from quality the viscosity (SAE grades) must also be observed when selecting engine oils. Information on this can be found on Sheets 223.1 or 223.2 and on Sheets 224.1 or 224.2. Not every grade of approved engine oil is available with its respective viscosity grade. Single-grade engine oils are only approved for certain types of engine in summer. Today, they should only be used in pronouncedly warmer climes (in the corresponding SAE class).