Liquid fuels for gasoline engines are mixtures of chain and ring-shaped hydrocarbons as well as certain oxygenic compounds (ether, alcohol), that have a boiling point between approximately 30 and 200 °C and are almost exclusively extracted from mineral oil. In each country they are offered for sale in either one or several grades. Three gasoline grades are sold in the Federal Republic of Germany, all of which are specified in terms of both properties and quantity in DIN EN 228:

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| | | | |
|---|---|---|---|
| Gasoline, Super Plus | DIN EN 228 | -SP- | unleaded |
| Gasoline, Premium | DIN EN 228 | -S- | unleaded |
| Gasoline, Regular | DIN EN 228 | -N- | unleaded |

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**Requirements, properties, parameters**

Fuel is subject to particular requirements aimed at enabling a gasoline engine to be operated reliably under all manner of climatic and driving conditions.
In order to comply with such requirements a variety of specifications must be adhered to which reveal information on the quality of the gasoline.

Although these specifications, which as a rule are based on standardized test procedures, are indeed useful, they do not always fully satisfy the need to define important quality criteria for handling gasoline and for its combustion in the engine.

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A certain number of such specifications, for which limit values have been defined, are called on to compile standards for minimum requirements. The valid requirement standard within the EU is EN 228 (adopted in Germany as DIN EN 228, see sheet 122.2), which lays down the permissible limit values. According to this, gasoline may also contain additives for improvement, likewise certain alcohols and ethers are permitted in limited quantities.
In our opinion the addition of additives to gasoline to improve quality is absolutely essential. This has to take place through the supplier as he has overall responsibility for his product (refer to the Section "Additives" on this).

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**Anti-knock rating**

The anti-knock rating is one of the most important quality features in motor-vehicle gasoline. It is decisive in ensuring a normal combustion process in the engine and thus crucial in terms of efficiency and specific power output.

The anti-knock rating is measured by the octane rating which in turn is determined through comparison with isooctane-n-heptane mixtures in a C.F.R. engine as under ISO 5163 and ISO 5164. Essentially one differentiates between two methods of determination:

a) F 1 method, Research Octane Number (RON) ISO 5164

b) F 2 method, Motor Octane Number (MON) ISO 5163

The differences lie in the various testing conditions. In RON, one conducts the test with a constant engine speed of 600 rpm, a constant spark setting (13 ° before BTDC) and with air preheated air to 52 °C, in the MON method one uses a constant engine speed of 900 rpm, an automatically-adjustable spark setting depending on compressed ratio and a mixture preheated to 149 °C.

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Next to the RON and MON methods there is also the FON (Front Octane Number) and the SON (Street Octane Number). The FON is the research octane number of the constituents that dissolve into a vapor state during distillation up to 100 °C. It has a specific significance with regard to the knocking during acceleration characteristic.

SON is measured in the vehicle's engine, because the fuel is assessed differently in every engine on account of its different design and operating conditions than would be prevalent in a C.F.R. test engine. The measurement draws on both primary reference fuels (compound of isooctane and n-heptane) as well as specified fuels with maximum boiling ranges. The measurement is conducted during straight-line non-knocking full-throttle acceleration in the highest gear from the lowest possible speed.

A vehicle's octane number requirement can be taken from the owner's manual.

The anti-knock rating of conventional gasoline differs greatly from country to country, a list is available on Sheets 124.0/.1/.2/.3/.4.

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**Boiling-point curve and vapor pressure (volatility)**

The gasoline's boiling-point curve lies between approx.
215 °C. Important in the context of the boiling-point curve are its start with the so-called 10 % point, the 50 % point and the final boiling point.

For this reason the boiling-point curve is different for summer fuels than it is for winter ones.

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The boiling-point curve alone however does not determine the volatility of a fuel, for this reason the vapor pressure is measured at 37.8 °C to provid has become irrelevant. As part of the European standardization process a modern vapor pressure method such as the EN 13016 T 1 has been standardized and incorporated into EN 228 as of issue 2/99. EN 13016 T. 1 delivers the "ASVP" ("Air Saturated Vapor Pressure") as a measured quantity, which can be converted by means of a correction formula to render the "DVPE" ("Dry Vapor Pressure Equivalent"). For fuels containing alcohol the "Reid vapor pressure" provides slightly lower values than the "DVPE", non-alcohol fuels are evaluated identically.

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DIN EN 228 specifies the "DVPE" vapor pressure in summer to min. 45 and max. 60 kPa as well as for the winter to min. 60 and max. 90 kPa (100 kPa = 1 bar). In the transitional period during spring and fall the vapor pressure requirements for winter fuel are valid, but with an additional requirement in terms of the "VLI" ("Vapor Lock Index", a mathematical value: VLI = 10 * DVPE + 7 * E70) of max 1150, when the vapor pressure is fully exploited (e.g. 90 kPa) this limits the permissible vaporized pressure at 70 °C ("E 70") to max.
28.5 vol %.
The European standard provides an opportunity, to also define the vapor pressure curve above 37.8 °C (from 40 °C up to 100 °C) (EN 13016 T. 2). There are as yet hereto no limit values.
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**Density**
Density is related to 15 °C as under DIN 51757 and ISO 3675 because of the volume which changes with the temperature. Density requirements as under DIN EN 228 for regular, premium and super plus are 0.720 up to 0.775 kg/m3.

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**Calorific value**
The calorific value of the fuel indicates which quantity of heat is liberated when it is combusted, i.e. how much energy is contained in a particular quantity of fuel. The

In fuels that consist solely of carbon (C) and hydrogen (H), the calorific value is dependent on their C and H concentrations, this is because H has a calorific value of

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| | C/H ratio | d15 °C | calorific value | calorific value |
|---|---|---|---|---|
| | % by weight | (kg/l) | (MJ/kg) | (MJ/l) |
| Regular | 86.5/13.5 | 0.730 | 43.5 | 31.8 |
| Premium | 87.5/12.5 | 0.765 | 42.7 | 32.7 |

i.e. the energy contained in 1 liter of premium fuel is approx. 2.8% greater than in 1 l of regular fuel

If the fuel contains oxygenic components, the oxygen will not contribute anything to its calorific value. The oxygen content should therefore be subtracted. This is to a certain extent compensated for by the higher H content in the oxygenic compounds, so that where the proportion is not too high (see section on "Oxygenic components") the calorific value is only insignificantly influenced.

**Purity**
Solid foreign matter and water may lead to problems arising with the fuel supply.Beyond this water can also cause corrosion; in turn corrosion products can also impair the fuel supply.
The solid residue from evaporation of the fuel (50 ml of the fuel is evaporated by the air-jet method in a glass beaker at a temperature of 160 °C) gives an indication of the degree of contamination to be expected in the intake system.Oily solid residue from evaporation is less harmful, but paint or resin residue from evaporation is less favorable.
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**Sulfur content**
The sulfur content in the gasoline should be as low as possible, we recommend the use of
sulfur-free fuel in in Mercedes-Benz vehicles. For additional information, refer to Sheet 126.0 "Sulfur in gasoline".

**Stability**
The quality of the fuels should not deteriorate on the more or less long journey from the manufacturer to the consumer, i.e. the hydrocarbons in the fuel should not react with the oxygen in the air or with each other. This chemical instability results from the presence of unsaturated hydrocarbons in the fuel (e. g. diolefin) and is responsible for the so-called "gum" formation. This makes itself noticed through deposits throughout the entire fuel and intake systems and the intake valves.

Criteria such as the oxidation stability as under ISO 7536 and the solid residue from evaporation are called on for assessment purposes.

Currently however, a proper quality assessment can only be made through a complete engine test.
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**Corrosion**
Fuels are naturally practically anhydric, but they are known to dissolve small quantities of water when being transported. The dilution is dependent on the structure of the hydrocarbons as well as the temperature. When cooling down a portion of the diluted water is lost. Water and fuel are separated. As long as the water is dissolved, it does not have a corrosive effect. Free water causes rust and corrosion to effect both ferrous and non-ferrous metals.

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**Fuel agents, additives**

In order to fulfill the specified requirements, additives are added to the fuel. Gasoline additives are split up into two categories:

Additives, that are intended to change or improve the fuel's characteristics.

Additives, that are intended to give the fuel new or additional characteristics.

Here one also has to differentiate between additives for transport and storage purposes, and those that are effective in the engine-related combustion process.

Amongst the additives one counts dyes with which, for safety reasons, leaded fuels can be identified.
The color is not prescribed, but left to the discretion of the manufacturer, who can select specific colors to identify its own fuels by.

The sketched-out gasoline additive process, which is important, in particular, in terms of system purity and protection against corrosion, has enormous significance i

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The oxygen content relates to the entire mass share of oxygen, which is present in the fuel as a result of the oxygenic components. Consequently, it is not practical to fully utilize all the maximum permissible peak values simultaneously for each individual component.

The fuel manufacturer is obliged to ensure that all gasoline fuels that contain oxygenic components do not exhibit any disadvantages when compared with fuels that do not contain oxygenic constituents.

**Oxygenic components**

Gasoline fuels have oxygenic components added to them for a number of reasons (in the main these are of economical nature, sometimes they have to do with increasing the anti-knock rating).

As a rule these are alcohols and ethers; most frequently the alcohols methanol
and tertiary butane and as ether methyl.tertiary butyl ether (MTBE) are used.

Because oxygenic components can alter a fuel's characteristics, many industrial nations have made moves towards governing their usage. The regulations applicable within the EU will be gone into in detail shortly.

The maximum permissible concentrations of these components, which are also specified within DIN EN 228, are as follows:

| | | |
|---|---|---|
| Methanol | 3 | vol % |
| Ethanol | 5 | vol % |
| Isopropanol | 10 | vol % |
| Tertiary butane | 7 | vol % |
| Isobutane | 10 | vol % |
| Ether (min. 5 C atoms) | 15 | vol % |
| Oxygen content | 2.7 | % by weight |

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