

## Enclosure 1 to SI 13 06 96 (139), edition 02/2019

Fuels are mainly produced from crude oil using chemical/physical procedures. To a small extent, petrol is also made from coal or plants.

In the refinery, the crude oil undergoes different processes, where it is split up into different components. Fuels with the desired properties are then mixed from these components .

The fuel properties are influenced through suitable supplements (additives), thus ensuring trouble-free engine operation with optimum energy efficiency.

Although petrols have different property value world-wide, they are nevertheless all suitable for the operation of BMW Group engines when complying with certain limit values.

- *Petrol* is the collective term for hydrocarbons of different structures and production methods
- *Regular-grade fuel* is petrol with a knock resistance RON 91.0/MON 82.5
- *Premium grade fuel E10* is petrol with a knock-resistance level of RON 95
- *Premium grade fuel* is a mixture with highly knock-resistant portions and thus has a higher knock resistance than regular grade fuel (RON 95/MON 85). In addition, "Super Plus" fuels are also available (RON 98/MON 88)
- *Unleaded fuel* does not contain any metalliferous antiknock additives, such as e. g. lead tetraethyl or lead tetramethyl.

Unleaded fuel is offered as regular-grade, premium-grade and premium grade plus fuel according to European standard 228.

## Enclosure 2 to SI 13 06 96 (139), edition 02/2019

Fuels that can be used for petrol engines are mixtures of ring and chain-like hydrocarbons, with typical boiling points of between 30°C and 200°C. They are offered world-wide in different qualities.

Properties and specifications for leaded fuels are specified in DIN 51 600, for unleaded fuels in European standard 228.

For use in BMW Group vehicles, it is permissible to admix fuel components containing oxygen up to the limit values specified in European standard 228 (maximum methanol 3 %, maximum ethanol 5 %).

No changes result from the introduction of the new E10 fuels. E10 is a classification used for petrols with up to ten percent ethanol whose introduction is planned by German legislation as part of the implementation of the new EU Fuels Quality Directive 2009/30 (FQD).

The fuels with a biogenic portion can then lead to a further reduction in CO<sub>2</sub> emissions without requiring an upgrade in the vehicle.

E10 fuels can be used in all BMW Group vehicle models of all series without ill effects. However, regardless of the ethanol content, the minimum required octane number as specified in the operating instructions must be observed since some older BMW Group vehicles require Super Plus RON 98 due to its higher knock resistance (see table below).

Properties and specifications for E10 fuels are defined in the E DIN 51 626-1.

The following BMW Group vehicle models for which the operating instructions explicitly specifies 98 octane fuel must continue to be refuelled with Super Plus (E DIN 51626-1, issue date April 2010):

| Year of manufacture | Models                                                           | Type code                                                |
|---------------------|------------------------------------------------------------------|----------------------------------------------------------|
| 1960-1964           | 700s, 700cs                                                      | 310, 311                                                 |
| 1968-1977           | 2500, 2600, 2800, 2.8L, 3.0L, 3.0si, 3.3L, 3.3Li                 | 329, 357, 358, 370, 371, 378, 383, 384, 389, 390         |
| 1968-1975           | 2800cs, 2.5cs, 3.0cs, 3.0csi, 3.0csl                             | 359, 363, 364, 380                                       |
| 1966-1975           | 2000ti, 2002ti, 2002tii, 2002turbo                               | 332, 360, 361, 369, 377                                  |
| 1962-1974           | 1600GT, 1600ti, 1800ti, 1800tsia                                 | 321, 323, 326, 338, 341                                  |
| 1972-1981           | 518 (92 KW), 520, 525, 528, 520i, 525i, 528i, M5 535i            | 373-375, 379, 382, 391, 394, 395, 401-403, 410, 415, 419 |
| 1965-1970           | 2000cs (88 KW), 2000tiux                                         | 315, 337                                                 |
| 1975-1983           | 315, 318i, 320i, 323i                                            | 388, 405, 416-418, 437                                   |
| 1978-1983           | 316                                                              | 385                                                      |
| 1976-1983           | 320                                                              | 404                                                      |
| 1977-1986           | 728, 730, 728i, 733i, 735i (145/160 KW), 745i                    | 397-399, 412-414, 432, 444                               |
| 1976-1989           | 625cs, 628csi, 630cs, 633csi, 635csi (160 KW)                    | 392, 393, 406-409, 411, 424, 425, 446, 467               |
| 1978-1984           | M 635csi (210 KW)                                                | 434                                                      |
| 1978-1980           | M1                                                               | 301                                                      |
| 1981-1987           | 518, 518i, 520i, 525e (92/95 KW), 525i, 528i, M535i (141/160 KW) | 420-423, 430, 435, 436, 442, 450, 451                    |
| 1982-1994           | 318i (77 KW), 320i, 325e (95 KW), M3                             | 302, 303, 305, 427-429, 433, 459                         |
| 1982-1987           | 316                                                              | 426, 500                                                 |
| 1982-1987           | 320i (95 KW)                                                     | 452, 453, 477, 502                                       |

|           |                                                      |                                                                         |
|-----------|------------------------------------------------------|-------------------------------------------------------------------------|
| 1982-1987 | 325i (126 KW)                                        | 448, 449, 454                                                           |
| 1952-1969 | Dixie, Goggo, 309, 501 to 507, 602, 3200, Alpina B10 | 300, 302, 303, 305, 307, 316, 320, 327, 328, 330, 331, 333-335, 345-351 |

To ensure the required operating characteristics in all environmental and driving conditions, high demands are placed on fuels. To meet these requirements, a variety of data must be specified and used to compare the quality.

#### *Knock resistance:*

The knock resistance as a quality feature for petrol is the prerequisite for a controlled combustion process and thus crucial for the compression configuration, the efficiency and the engine performance.

The octane number is used as a measure. The higher the number, the more knock resistant the fuel. To determine the octane number, two different procedures are used internationally:

The RON (research octane number) and the MON (motor octane number).

The difference between the two methods is in the mixture preheating, the engine speeds and the modified ignition timing setting.

#### *Density*

The density is determined by the fuel components. Because volume changes with temperature, density is measured at 15°C in accordance with the standard. Because of the different compositions, there are different values for mid-grade and regular-grade fuel.

#### *Boiling curve and vapour pressure*

Petrols must be free-flowing. The boiling curve and the vapour pressure values are used for evaluation purposes. Petrols do not have a boiling point but a boiling range, since they consist of a mixture of different hydrocarbon components.

The boiling range (boiling curve) and thus the vapour pressure influence e. g.:

- Formation of fuel vapour lock
- Starting response
- Evaporation loss
- Transient response and drivability
- Engine oil dilution
- Residue-free combustion

The boiling curve is different for summer and winter-grade fuels. European standard 228 specifies the amount to be evaporated at 70°C, 100°C and 150°C as well as the final boiling point. The vapour measurement is another tool used to make statements on the volatility properties of the fuel and is also specified in the standards.

#### *Calorific value*

The calorific value is the measurement for the energy content of the fuel. Engine output is relative to the calorific value of the combustible fuel-air mixture.

#### *Purity, combustion residues*

Fuels must be free from dirt contamination. Pumps, air vents and lines must not clog up or wear. Residues in the differentiated intake system and in the combustion chamber affect the operating sequence in the engine. The waste steam residue in the fuel provides on the degree of dirt contamination.

#### *Sulphur content*

All fuels must have the lowest sulphur values possible. As a result, less sulphurous acid or sulphuric acid is formed in the combustion residues, which would lead to corrosion and pollutant emission of sulphur compounds in engines that are not at operating temperature.

#### *Fuel additives, additives*

To meet the listed requirements, the fuel companies mix additives to their fuels, including colours for identification purposes among other things.

It is up to the fuel companies, which colours they use to identify the fuels.

The selection, use and metering of the additive requires comprehensive tests in order to co-ordinate influences and interconnections.

No extra supplements are required in BMW Group vehicles in addition to the additives admixed by the fuel manufacturer.

#### *Fuels with lead substitute*

Use of unleaded fuel with lead substitutes added by the manufacturer is approved. *Subsequent* admixing of lead substitutes in unleaded fuels is *not approved* .

## Enclosure 3 to SI 13 06 96 (139), edition 02/2019

### *Leaded fuel:*

| Properties       | Requirements       | Test specifications   |
|------------------|--------------------|-----------------------|
| Knock resistance | Min. 98.0 RON      | ISO 5164              |
|                  | Min. 88.0 MON      | ISO 5163              |
| Density at 15 °C | 0.730 - 0.780 g/ml | ISO 3675/ASTM D 4052  |
| Lead content     | max. 0.15 g/l      | European standard 237 |

*Unleaded petrols:* Extract from DIN 51 607/EN 228 - version August 1989

| Properties           | Requirements                 | Test specifications   |
|----------------------|------------------------------|-----------------------|
| Knock resistance     |                              |                       |
| - normal             | min. 91.0 ROZ*min. 82.5 MON* | ISO 5164ISO 5163      |
| - Mid-grad fuel      | min. 95.0 ROZ*min. 85.0 MON* | ISO 5164ISO 5163      |
| - Premium grade fuel | min. 98.0 ROZ*min. 88.0 MON* | ISO 5164ISO 5163      |
| Density at 15 °C     | 0.725 - 0.780 g/ml           | ISO 3675/ASTM D 4052  |
| Lead content         | max. 0.013 g/l               | European standard 237 |

\* Manufacturer and/or supplier are obligated to provide a research octane number of 0.5 and a motor octane number of 0.7. The provision values are the result of ISO 4259 under the preconditions of the separation analysis in the CRF engine.

## **Enclosure 4 to SI 13 06 96 (139), edition 02/2019**

A special cleaning fluid is needed to clean the fuel injector in the ultrasonic sound device.

| <b><i>Trade name</i></b> | <b><i>Order number</i></b> | <b><i>Container size</i></b> |
|--------------------------|----------------------------|------------------------------|
|--------------------------|----------------------------|------------------------------|

|                     |                 |          |
|---------------------|-----------------|----------|
| SPX special cleaner | 83 30 0 491 350 | 10 litre |
|---------------------|-----------------|----------|

### **Company**

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## Enclosure 5 to SI 13 06 96 (139), edition 02/2019

The most important prerequisite for an economic and trouble-free operation of the diesel engine is a clean and good quality of the diesel fuel.

Diesel fuel is a mixture of hydrocarbons that are derived by boiling at 180 ° to 380 °C and distillation, generally from crude oil, less commonly from plants.

Diesel fuels that are readily available on the free market are adjusted for the requirements of fast running diesel engines.

BMW diesel engines require fuels in compliance with EN 590 with a minimum cetane number of 51. The use of heating fuels, marine fuels or biodiesel fuels is prohibited. \*The use of larger parts of fuels such as "biodiesel" or "rapeseed methyl ester" will result in leaks that can cause considerable subsequent damage. Exception: M47, M51, M57 with SA201 "RME Version".

The following criteria are important to determine the quality of diesel fuels:

### *Ease of ignition:*

The cetane number (CZ) indicates the diesel fuel's ease of ignition. The larger this number is, the more easily the fuel will ignite. The ease of ignition is the property of the fuel that effects the self-ignition in the diesel engine. Sufficient ease of ignition is the basic prerequisite for a normal controlled and no-knock combustion process. The cetane number is specified in a test engine in compliance with ISO 5165. Due to the shorter combustion process, fast running diesel engines require diesel fuels with high cetane numbers.

### *Low temperature performance*

Diesel fuels emit paraffin at low temperatures. In the field, the fuel is adjusted to the season. For example, the standard BMW fuel heating unit provides a temperature resistance up to approximately -22°C during the coldest time of winter. Operation of vehicles that were fuelled with fuel during the summer in the wintertime can lead to vehicle failure. When driving from warm regions to a cold mountain region (fuel tank range up to 1,000 km!), the cold resistant diesel fuel should be added to the tank prior to the end of the trip.

### *Sulphur content*

The lubricity of this diesel fuel is reduced during the desulphurising process at the refinery. This is compensated by adding so called lubricity additives so that the lubricity is ensured for all brands of diesel fuels.

### *Purity*

Due to the exact dimensional accuracy in the high-pressure fuel system, purity is a prerequisite for the function and service life of the diesel engine. The water content to prevent corrosion may not exceed 200 mg/kg. The ash content is specified with 0.01% to prevent above-average coking of nozzles and combustion deposits. The residue is also specified according to the standard.

Standard test procedures have been implemented to indicate the requirements for the diesel fuel. They are used to define the most important quality criteria and minimum requirements. For example, EN 590 applies in the European Union. Its specifications include that the diesel fuel consists of hydrocarbons and can be improved with hydrocarbon soluble additives.

\* EN 590 permits the addition of a maximum of 7% biodiesel (fatty acid methyl ester content).

## Enclosure 6 to SI 13 06 96 (139), edition 02/2019

Extract from draft EN 590 from February, 2000

| Properties                         | Requirements       | Test specifications DIN                               |
|------------------------------------|--------------------|-------------------------------------------------------|
| Density at 15 °C                   | 0.820 - 0.845 g/ml | EN ISO 3675: 1998<br>EN ISO 12185: 1996               |
| Sulphur content                    | max. 0.035 %       | EN ISO 14596: 1998<br>EN ISO 8754: 1995EN 24260: 1994 |
| Water content acc. to Karl Fischer | max. 200 ppm       | prEN ISO 12937: 1996ASTM D 1744                       |
| Ease of ignition:                  |                    |                                                       |
| Cetane number (test engine)        | min. 51            | EN ISO 5165: 1998                                     |

2 = CFPP range of winter-grade diesel engines

Note: The petroleum must be added before the filtration limit is reached, even if the temperature of the fuel system is at least 8°C above the cloud point (summer fuel: +8°C, winter fuel: 0°C). The addition is ineffective if paraffin precipitation has already taken place. In this case, only the heating of the fuel system can help, for example, by heating the vehicle in a warm room or, in most cases, by replacing the fuel filter cartridge.

For safety reasons (explosion hazard), the method used so far (only for swirl chamber engines!) of adding up to 30% regular-grade fuel to diesel fuel in order to ensure the flowability of the fuel may only be used if petroleum is not available. Special reference must be made to the safety risk! In this case, a higher combustion noise and driving behaviour disturbances must be accepted due to the petrol components. Driving with petrol additive (only with swirl chamber engines!) must be limited to the duration necessary due to temperature.

The use of flow improvers previously approved by the BMW Group is no longer permitted for the following reasons:

- Improved additives for winter-grade diesel fuels down to -20°C in the winter season
- Risk of overaddition with negative effects on cold properties

## Enclosure 8 to SI 13 06 96 (139), edition 02/2019

Cleaning agent for the degradation of fuel combustion residues in mechanically and electronically controlled diesel injection systems (BMW swirl chamber engines):

| <i>Trade name</i>  | <i>BMW part number</i> | <i>Container size</i> |
|--------------------|------------------------|-----------------------|
| BMW diesel rinsing | 81 22 9 407 528        |                       |

## **Enclosure 9 to SI 13 06 96 (139), edition 02/2019**

### **For BMW swirl chamber engines (M21, M41, M51)**

A special cleaning fluid is needed to clean the injector nozzles in the ultrasonic sound device.

| <b><i>Trade name</i></b> | <b><i>Order number</i></b> | <b><i>Container size</i></b> |
|--------------------------|----------------------------|------------------------------|
|--------------------------|----------------------------|------------------------------|

|                     |                 |          |
|---------------------|-----------------|----------|
| SPX special cleaner | 83 30 0 491 350 | 10 litre |
|---------------------|-----------------|----------|

| <b>Company</b> | <b>Tel.: 0841 / 9 65 00 - 70 or 71 (domestic)</b> |
|----------------|---------------------------------------------------|
|----------------|---------------------------------------------------|

|              |                                                        |
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|-----------------------------|--------------------------------------------------------------|
| D-85053 Ingolstadt, Germany | E-Mail: <a href="mailto:info@cartool.de">info@cartool.de</a> |
|-----------------------------|--------------------------------------------------------------|

## Enclosure 10 to SI 13 06 96 (139), edition 02/2019

For the safe storage, disposal and conversion of fuels, the authorities issue "regulations for combustible fluids".

For the purpose of this regulation, combustible fluids are substances with a flash point, which, at 35°C, are neither solid nor in paste form, and have a vapour pressure of 3 kg/cm or less at 50°C and belong to one of the following groups:

### *Group A:*

Fluids that have a flashpoint not exceeding 200°C and do not have properties of group B with regard to water-solubility.

#### **Danger classification I: Fluids with a flashpoint up to 21°C**

Danger classification II: Fluids with a flashpoint 21 – 53°C

Danger classification III: Fluids with a flashpoint 55 – 100°C

Petrols are part of group A/I. Kerosene and white spirit are part of group A/II. Diesel fuel is part of group A/III.

### *Group B:*

Fluids with a flashpoint of below 21°C, which dissolve in water at 15°C at any ratio or whose combustible liquid elements dissolve in water at 15°C at any ratio.

This includes alcohols.

Specific regulations apply to each danger classification. They can be viewed or requested from the authorities responsible.