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Diesel

Frequently Asked Questions (FAQs)

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Content

What is diesel and what is biodiesel?

Diesel (also known as diesel fuel or diesel oil) is a mixture of various hydrocarbons that is a suitable fuel for a diesel engine.

In Europe, diesel for passenger vehicles and trucks must fulfill the requirements of DIN EN 590. In the US, the relevant standard here is ASTM D975. The NATO standard F-54 corresponds in terms of content with the standard DIN EN 590.

Biodiesel, in chemical terms a fatty acid methyl ester (also known as FAME), is a fuel that is used as substitute equivalent for mineral diesel.

Following modification of DIN EN 590 (Edition of May 2010) to meet the requirements of the EU Guideline 98/70/EU, an admixture of up to 7% biodiesel by volume is permitted for compliance with the Biofuel Quota Act.
Mixtures of biodiesel and mineral diesel are referred to as blends. They are designated with a B and a number from 1 to 99; the number represents the percentage of biodiesel in the blend. According to this nomenclature, B100 is the designation for pure biodiesel.

The EN 14214 standards (ASTM D 6751 in the US) describe the requirements the fatty acid methyl ester must meet before it can be used as a biodiesel.

The following can be used, for example: palm oil methyl ester (PME), sunflower methyl ester, rapeseed oil methyl ester (RME) – also known as rape oil methyl ester or rape diesel – and soy oil methyl ester (SME). In addition to these, methyl esters are also available that are based on used greases and animal fats, e.g. waste grease methyl ester (AME) and animal fat methyl ester (FME). No precise limitation is defined.

Why does diesel need to be filtered and dewatered?

As a result of the increasingly stringent requirements with respect to emission values being demanded by emissions standards (in Europe: EURO 1 – 6, in the US: TIER 1 – 4), consequently higher requirements are being made of diesel motor technology.

Thus, for example, the injection pressures in common rail systems have been increased to up to 3000 bar. This leads to lower tolerances in the entire system, which are in the range of 2 µm. Particle contamination is therefore to be avoided under all circumstances and a filtration is necessary.

Water in diesel fuel must be removed in order to protect the components of the motor. The water hinders the lubrication of the sensitive moving motor components and can also lead to rust formation.

In addition, the presence of water can also be regarded as a cause for the formation of diesel pest.

Ultimately, free water in the diesel fuel can freeze in the presence of cold ambient temperatures, thus blocking components or interrupting the fuel flow.

How thoroughly should diesel be filtered and dewatered?

It is not possible to give an answer to this question that is valid in all circumstances. Generally speaking, it can be assumed that older motors can function with higher levels of contamination than modern ones can. This applies in equal measure to the water content.

Current values from the specifications for modern motors and their components are displayed in the following table (Status 2014).

Company	Area	Recommended cleanliness class (according to ISO 4406)	Max. water content
Bosch	Injector	12/09/07	
Denso	After pre-filter and main filter	16/13/08	<200 ppm (no free water)
CAT	Pump nozzle and older systems	Max. 18/16/13	<500 ppm free water
CAT	Common rail	Max. 16/13/11	<500 ppm free water
MTU	Tank	18/17/14	200 mg/kg

Where do water and dirt in diesel come from?

Contaminations of the diesel with dirt and water can occur within the entire supply chain, from the refinery through intermediate storage all the way to the vehicle tank.

It can occur every time the tank is filled or also as a result of tank breathing. The refining process can be understood as a sterilization of the diesel; the fuels can however also become contaminated again through transport and storage just a short time after the distillation process.

Reasons for this are, for example:

- Condensation due to temperature fluctuations
- Tank "breathing" during draining and filling
- Open tank cap
- Machine cleaning with water
- Dust exposure on building sites or in dry areas
- Human error
- Criminal tampering

How high is the critical water content for diesel?

Current specification values are contained in the table in the answer to Question 0.

Practical experience shows however that the answer to this question is not really so simple. As can be seen from the following figures, the possible solubility of water in diesel is dependent on the type of diesel and the temperature. Biodiesel can absorb considerably more water than mineral diesel.

At an ambient temperature of 25 °C, B7 diesel can dissolve approx. 90 ppm of water. In addition, free water can also appear in the tank.

Rapeseed oil (B100) can, on the other hand, dissolve around 1,000 ppm of water at the same temperature of 25 °C. It is therefore not possible to achieve a water content with conventional dewatering methods (coalescence, centrifugal filter, super absorbers) as it is required by the Denso Co. or by MTU.

Within limits, it can be stated that, in accordance with EN 14214, the maximum water content in biodiesel is limited to 500 mg/kg when it is used in diesel motors or as heating oil.

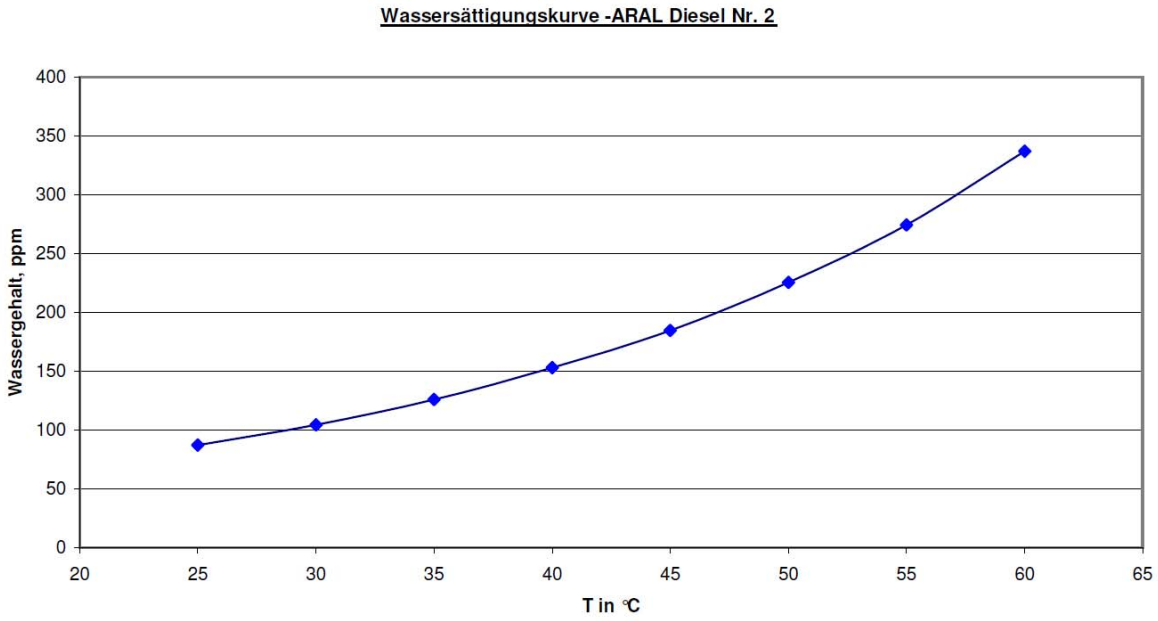

Figure 1: Water saturation curve for Aral Diesel (B7, Germany, Summer 2013)

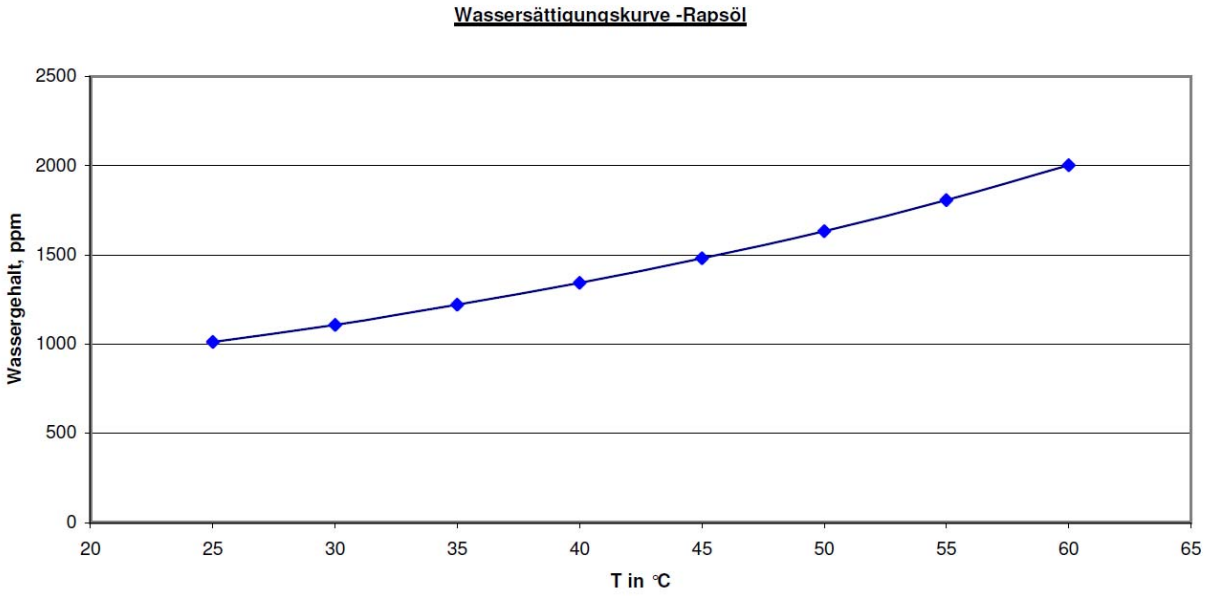

Figure 2: Water saturation curve for rapeseed oil (B100, France, 2013)

The incidence of free water is to be considered critical. See also Question 0 for more on the problems that result from it.

What is the difference between specifications in ppm and mg/kg?

The term ppm is used in the area of oil hydraulics, primarily to describe water contents. ppm stands thereby for parts per million (0.01 % corresponds to 100 ppm). A distinction is to be made here between whether this specification is used purely as a volumetric observation or whether it refers to the weight. A volumetric observation appears as follows: A tank filled with 5,000 liters and with a water content of 200 ppmv in the diesel contains 1 liter of water (rough calculation).

Calculation procedure: 5,000 liters * 0.0002 = 1 liter

Specifications in mg/kg are usually used in the fuels area. This corresponds to mass-ppm. This device has the effect that the different densities of the operating fluids must be taken into account. This means the density of the water (~1 kg/l) and that of the diesel (~0.83 kg/l): In a tank with 5000 liters and a water content of 200 mg/kg, this means that there is approx. 0.83 liters of water present

Calculation procedure:

5000 liters * 0.83 kg/l = 4150 kg (diesel)
4150 kg (diesel) * 200 mg/kg (water content) = 830,000 mg = 0.83 kg (water)
0.83 kg (water) / 1 kg/l = 0.83 l

From this it can be seen that, due to the influence of density, specification in mg/kg (or ppm) yields somewhat lower values than specification in ppmv.

A Karl Fischer Test for water determination yields a value for weight ppm as the result. A WaterTest Kit (WTK 400) specifies a volumetric ppm value (ppmv).

What is diesel pest?

Diesel pest is understood to mean the growth of microorganisms (e.g. bacteria, yeasts, fungi) that can cause filter blockages through the formation of bio sludge and damage to the fuel systems (tanks, pipelines, pumps, motors).

These microorganisms can survive, grow and multiply only at the border surface between the water and the fuel. In order to multiply, these microorganisms require water, nutrients and a suitable temperature. Light also promotes their growth. Because of the fact that the heating and vehicular fuels, as organic substances, represent nutrients for microorganisms, the water concentration in the fuels is the limiting factor for microorganism growth.

What problems does diesel pest cause?

Microorganisms can populate practically all of the substances that occur in nature, and are often in a position to attack or even break down these substances. In order to multiply, these microorganisms require water, nutrients and a suitable temperature. Microorganisms are very adaptable - it is not until temperatures reach -18°C that bacterial growth is suppressed. In addition, there are also so-called thermophilic microbes which can multiply even at temperatures above 100°C. A favorable temperature is usually present in the tank and temperatures cannot always be influenced, e.g. with storage tanks outdoors. According the current DIN EN 590, specifications for diesel fuel permit a water content of up to 200 mg per kg. Because of the fact that the water is not usually dissolved in the fuel, but rather present as an emulsion, it settles downward over time and is then available for the growth of microorganisms.

The consequences of a microbiological infestation are manifold: microbial destruction results in losses of diesel quality and the metabolic products of the organisms destroy the material contained in tank walls, pipes and filter elements. Hydrogen sulfide (formed by the decomposition of the diesel) promotes corrosion and the resulting microbiological slime clogs filter elements, diesel and oil lines, water traps and injection pumps.

Is diesel pest a recent phenomenon?

No, as long ago as 1895, microorganisms were discovered which were able to multiply in hydrocarbons. The first problems with contaminated fuels were observed in 1956 with kerosene.

Because of biodiesel additives, nowadays the microorganisms are being offered components that lend themselves well to biological decomposition, thus leading to increased bio sludge formation. This leads to increased attention to the subject of diesel pest.

How can I verify the presence of diesel pest?

The HYDAC laboratory can carry out a microbiological investigation for the presence of fungi and yeast bacteria. A 250 ml sample of this fuel is sufficient.

Is there a rapid test for contaminations in diesel?

The WTK 400 is currently available as a rapid test for the determination of water content (in ppmv).

The use of the Aqua Sensor (AS) is theoretically conceivable, but in practice it would not provide any meaningful information. The AS measures the relative saturation level and would therefore always display 100% in the presence of free water and would become damaged over time. Given the fact that it is precisely free water that is the problem, the use of the AS is not productive.

The CS 1000 can be used for dirt. Integration in our hydraulic power units is however not yet possible at the moment. A dirt analysis can therefore be performed through the laboratory.

A check for the presence of diesel pest can at the moment also be performed only through the laboratory.

Once a tank has been contaminated with diesel pest, is it still vulnerable to it in the future?

It is difficult to clean out a tank that has been contaminated with diesel pest completely, because the microorganisms can colonize the entire system. Dewatering is advisable in any event in order to remove the conditions the microorganisms need to survive. In addition, chemicals can be added to the diesel in order to kill off any organisms that are still present in the system. These are then removed from the system through the filters (e.g. the LVU-CD in the bypass flow or the LVH-F downstream transfer filter).

Which tank systems are particularly endangered?

Diesel pest is mainly to be found in tanks that are rarely used and in which fuel is therefore stored for correspondingly long periods. Oil heating systems in houses that are rarely heated are also sometimes affected, as are emergency power units that, even in best-case scenarios, are put into operation only to check them for proper functioning. Diesel pest is most frequently found in the tanks of ships.

Furthermore, systems filled with biodiesel or blends are more likely to experience problems. This is to be traced back to the hydrophilic property of biodiesel, that also absorbs water from the humidity in the air.

With respect to dirt and water, it is particularly tanks that are exposed to areas with high dust loads (construction sites, arid regions) and/or high levels of air humidity and precipitation that are particularly at risk. High temperature fluctuations also have a negative effect and lead to higher loads of water.

Are tank systems with continuous diesel flow-through also affected?

Generally speaking, filtration should be provided for on all tanks in order to ensure the quality criteria required. In Europe, it can be assumed that highly frequented tanks are not contaminated with critical amounts of water (e.g. passenger vehicle gas stations). In areas of Southeast Asia, Africa, Russia and South America, however, quality cannot be ensured during transport, which means that the purities and water values necessary for today's motors are not necessarily being complied with. An additional dewatering is to be recommended here.

What filter fineness should filter elements have?

The filter fineness of the filtration elements in the bypass flow or in transfer filtration can be selected in accordance with the cleanliness requirements of the diesel. Typically, a fineness of 5 µm to 10 µm (beta > 200) is recommended. Additional information can be obtained from the data sheets of the respective products.

How does coalescence work?

Coalescence is used to describe the flowing together of finely distributed droplets, e.g. emulsion droplets, as are often present in the free water in the diesel.

In order to achieve this flowing together of droplets, the free water droplets contained in the diesel are guided to one another threads. They fuse with one another at the interfaces, thus forming larger droplets. The larger droplets are heavier than the individual small ones, which means that they fall to the bottom more quickly in the diesel, where they can thus be collected and removed from the diesel.

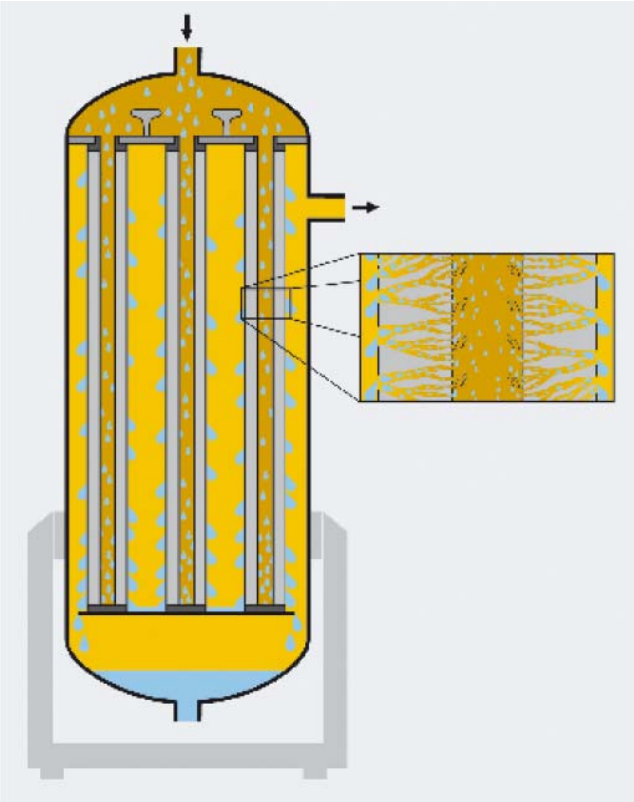

Fig 3: Coalescence of water in diesel

Which water contents can be reached with coalescence?

Only free water can be removed with coalescence. Removal of dissolved water is not possible. This means that, as a general rule, the saturation limit of the diesel used marks the maximum extent that it can be dewatered.

Everyday practice shows that the coalescence products from HYDAC can remove more than 99% of the free water.

How does a separation element work?

A separation element is comprised of one hydrophobic barrier layer at which water drops can be held back while diesel is able to pass through.