Diesel fuel

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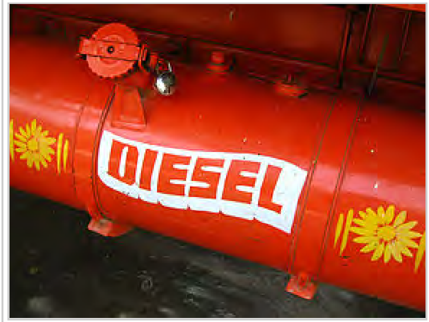


A tank of diesel fuel on a truck

Diesel fuel /ˈdiːzəl/ in general is any liquid fuel used in diesel engines, whose fuel ignition takes place, without any spark, as a result of compression of the inlet air mixture and then injection of fuel. (Glow plugs, grid heaters and heater blocks help achieve high temperatures for combustion during engine startup in cold weather.) Diesel engines have found broad use as a result of higher thermodynamic efficiency and thus fuel efficiency. This is particularly noted where diesel engines are run at part-load; as their air supply is not throttled as in a petrol engine, their efficiency still remains very high.

The most common type of diesel fuel is a specific fractional distillate of petroleum fuel oil, but alternatives that are not derived from petroleum, such as biodiesel, biomass to liquid (BTL) or gas to liquid (GTL) diesel, are increasingly being developed and adopted. To distinguish these types, petroleum-derived diesel is increasingly called **petrodiesel**.[1] Ultra-low-sulfur diesel (ULSD) is a standard for defining diesel fuel with substantially lowered sulfur contents. As of 2016, almost all of the petroleum-based diesel fuel available in UK, Europe and North America is of a ULSD type. In the UK, diesel fuel for on-road use is commonly abbreviated **DERV**, standing for *diesel-engined road vehicle*, which carries a tax premium over equivalent fuel for non-road use (see § Taxation).[2] In Australia diesel fuel is also known as **distillate**,[3] and in Indonesia, it is known as **Solar**, a trademarked name by the local oil company Pertamina.

Contents

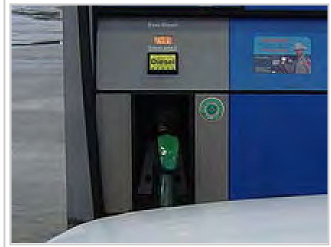
Origins

Diesel fuel originated from experiments conducted by German scientist and inventor Rudolf Diesel for his compression-ignition engine he invented in 1892. Diesel originally designed his engine to use coal dust as fuel,[4] and experimented with other fuels including vegetable oils[5] such as peanut oil, which was used to power the engines which he exhibited at the 1900 Paris Exposition and the 1911 World's Fair in Paris.[6]

Types

Diesel fuel is produced from various sources, the most common being petroleum. Other sources include biomass, animal fat, biogas, natural gas, and coal liquefaction.

Petroleum diesel


A modern diesel dispenser

Petroleum diesel, also called **petrodiesel**,[7] or fossil diesel is the most common type of diesel fuel. It is produced from the fractional distillation of crude oil between 200 °C (392 °F) and 350 °C (662 °F) at atmospheric pressure, resulting in a mixture of carbon chains that typically contain between 8 and 21 carbon atoms per molecule.[8]

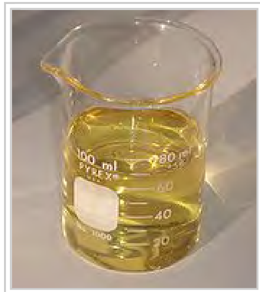
Synthetic diesel

Synthetic diesel can be produced from any carbonaceous material, including biomass, biogas, natural gas, coal and many others. The raw material is gasified into synthesis gas, which after purification is converted by the Fischer–Tropsch process to a synthetic diesel.[9]

The process is typically referred to as biomass-to-liquid (BTL), gas-to-liquid (GTL) or coal-to-liquid (CTL), depending on the raw material used.

Paraffinic synthetic diesel generally has a near-zero content of sulfur and very low aromatics content, reducing unregulated emissions of toxic hydrocarbons, nitrous oxides and particulate matter (PM).[10]

Biodiesel


Biodiesel made from soybean oil

Fatty-acid methyl ester (FAME), more widely known as biodiesel, is obtained from vegetable oil or animal fats (biolipids) which have been transesterified with methanol. It can be produced from many types of oils, the most common being rapeseed oil (rapeseed methyl ester, RME) in Europe and soybean oil (soy methyl ester, SME) in the US. Methanol can also be replaced with ethanol for the transesterification process, which results in the production of ethyl esters. The transesterification processes use catalysts, such as sodium or potassium hydroxide, to convert vegetable oil and methanol into FAME and the undesirable byproducts glycerine and water, which will need to be removed from the fuel along with methanol traces. FAME can be used pure (B100) in engines where the manufacturer approves such use, but it is more often used as a mix with diesel, BXX where XX is the biodiesel content in percent.[11][12]

FAME as a fuel is regulated under DIN EN 14214[13] and ASTM D6751.[14]

FAME has a lower energy content than diesel due to its oxygen content, and as a result, performance and fuel consumption can be affected. It also can have higher levels of NOx emissions, possibly even exceeding the legal limit. FAME also has lower oxidation stability than diesel, and it offers favorable conditions for bacterial growth, so applications which have a low fuel turnover should not use FAME.[15] The loss in power when using pure biodiesel is 5–7%.[12]

Fuel equipment manufacturers (FIE) have raised several concerns regarding FAME fuels: free methanol, dissolved and free water, free glycerin, mono and diglycerides, free fatty acids, total solid impurity levels, alkaline metal compounds in solution and oxidation and thermal stability. They have also identified FAME as being the cause of the following problems: corrosion of fuel injection components, low-pressure fuel system blockage, increased dilution and polymerization of engine sump oil, pump seizures due to high fuel viscosity at low temperature, increased injection pressure, elastomeric seal failures and fuel injector spray blockage.[16]

Unsaturated fatty acids are the source for the lower oxidation stability; they react with oxygen and form peroxides and result in degradation byproducts, which can cause sludge and lacquer in the fuel system.[17]

As FAME contains low levels of sulfur, the emissions of sulfur oxides and sulfates, major components of acid rain, are low. Use of biodiesel also results in reductions of unburned hydrocarbons, carbon monoxide (CO), and particulate matter. CO emissions using biodiesel are substantially reduced, on the order of 50% compared to most petrodiesel fuels. The exhaust emissions of particulate matter from biodiesel have been found to be 30% lower than overall particulate matter emissions from petrodiesel. The exhaust emissions of total hydrocarbons (a contributing factor in the localized formation of smog and ozone) are up to 93% lower for biodiesel than diesel fuel.

Biodiesel also may reduce health risks associated with petroleum diesel. Biodiesel emissions showed decreased levels of polycyclic aromatic hydrocarbon (PAH) and nitrited PAH compounds, which have been identified as potential cancer-causing compounds. In recent testing, PAH compounds were reduced by 75–85%, except for benz(a)anthracene, which was reduced by roughly 50%. Targeted nPAH compounds were also reduced dramatically with biodiesel fuel, with 2-nitrofluorene and 1-nitropyrene reduced by 90%, and the rest of the nPAH compounds reduced to only trace levels.[18]

Hydrogenated oils and fats

This category of diesel fuels involves converting the triglycerides in vegetable oil and animal fats into alkanes by refining and hydrogenation, such as H-Bio. The produced fuel has many properties that are similar to synthetic diesel, and are free from the many disadvantages of FAME.

DME

Dimethyl ether, DME, is a synthetic, gaseous diesel fuel that results in clean combustion with very little soot and reduced NOx emissions.[19]

Storage

In the US, diesel is recommended to be stored in a yellow container to differentiate it from kerosene and gasoline, which are typically kept in blue and red containers, respectively.[20] In the UK, diesel is normally stored in a black container, to differentiate it from unleaded petrol (which is commonly stored in a green container) and leaded petrol (which is stored in a red container).[21]

Measurements and pricing

Cetane number

The principal measure of diesel fuel quality is its cetane number. A cetane number is a measure of the delay of ignition of a diesel fuel.[22] A higher cetane number indicates that the fuel ignites more readily when sprayed into hot compressed air.[22] European (EN 590 standard) road diesel has a minimum cetane number of 51. Fuels with higher cetane numbers, normally "premium" diesel fuels with additional cleaning agents and some synthetic content, are available in some markets.

Fuel value and price

As of 2010, the density of petroleum diesel is about 0.832 kg/L (6.943 lb/US gal), about 11.6% more than ethanol-free petrol (gasoline), which has a density of about 0.745 kg/L (6.217 lb/US gal). About 86.1% of the fuel mass is carbon, and when burned, it offers a net heating value of 43.1 MJ/kg as opposed to 43.2 MJ/kg for gasoline. However, due to the higher density, diesel offers a higher volumetric energy density at 35.86 MJ/L (128,700 BTU/US gal) vs. 32.18 MJ/L (115,500 BTU/US gal) for gasoline, some 11% higher, which should be considered when comparing the fuel efficiency by volume. The CO_2 emissions from diesel are 73.25 g/MJ, just slightly lower than for gasoline at 73.38 g/MJ.[23] Diesel is generally simpler to refine from petroleum than gasoline, and contains hydrocarbons having a boiling point in the range of 180–360 °C (360–680 °F). The price of diesel traditionally rises during colder months as demand for heating oil rises, which is refined in much the same way. Because of recent changes in fuel quality regulations, additional refining is required to remove sulfur, which contributes to a sometimes higher cost. In many parts of the United States and throughout the United Kingdom and Australia,[24] diesel may be priced higher than petrol.[25] Reasons for higher-priced diesel include the shutdown of some refineries in the Gulf of Mexico, diversion of mass refining capacity to gasoline production, and a recent transfer to ultra-low-sulfur diesel (ULSD), which causes infrastructural complications.[26] In Sweden, a diesel fuel designated as MK-1 (class 1 environmental diesel) is also being sold; this is a ULSD that also has a lower aromatics content, with a limit of 5%.[27] This fuel is slightly more expensive to produce than regular ULSD.

Taxation

Diesel fuel is very similar to heating oil, which is used in central heating. In Europe, the United States, and Canada, taxes on diesel fuel are higher than on heating oil due to the fuel tax, and in those areas, heating oil is marked with fuel dyes and trace chemicals to prevent and detect tax fraud. "Untaxed" diesel (sometimes called "off-road diesel") is available in some countries for use primarily in agricultural applications, such as fuel for tractors, recreational and utility vehicles or other noncommercial vehicles that do not use public roads. This fuel may have sulfur levels that exceed the limits for road use in some countries (e.g. US).

This untaxed diesel is dyed red for identification,[28] and using this untaxed diesel fuel for a typically taxed purpose (such as driving use), the user can be fined (e.g. US$10,000 in the US). In the United Kingdom, Belgium and the Netherlands, it is known as red diesel (or gas oil), and is also used in agricultural vehicles, home heating tanks, refrigeration units on vans/trucks which contain perishable items such as food and medicine and for marine craft. Diesel fuel, or marked gas oil is dyed green in the Republic of Ireland and Norway. The term "diesel-engined road vehicle" (DERV) is used in the UK as a synonym for unmarked road diesel fuel. In India, taxes on diesel fuel are lower than on petrol, as the majority of the transportation for grain and other essential commodities across the country runs on diesel.

Taxes on biodiesel in the US vary between states; some states (Texas, for example) have no tax on biodiesel and a reduced tax on biodiesel blends equivalent to the amount of biodiesel in the blend, so that B20 fuel is taxed 20% less than pure petrodiesel.[29] Other states, such as North Carolina, tax biodiesel (in any blended configuration) the same as petrodiesel, although they have introduced new incentives to producers and users of all biofuels.[30]

Uses

Unlike gasoline and liquefied petroleum gas engines, diesel engines do not use high-voltage spark ignition (spark plugs). An engine running on diesel compresses the air inside the cylinder to high pressures and temperatures (compression ratios from 14:1 to 18:1 are common in current diesel engines); the engine generally injects the diesel fuel directly into the cylinder, starting a few degrees before top dead center (TDC) and continuing during the combustion event. The high temperatures inside the cylinder cause the diesel fuel to react with the oxygen in the mix (burn or oxidize), heating and expanding the burning mixture to convert the thermal/pressure difference into mechanical work, i.e., to move the piston. Engines have glow plugs and grid heaters to help start the engine by preheating the cylinders to a minimum operating temperature. Diesel engines are **lean burn** engines,[31] burning the fuel in more air than is needed for the chemical reaction. They thus use less fuel than **rich burn** spark ignition engines which use a stoichiometric air-fuel ratio (just enough air to react with the fuel). As Professor Harvey of the University of Toronto notes, "due to the absence of throttling [constant amount of air admitted, per unit fuel, with no user-determined variation], and the high compression ratio and lean fuel mixture, diesel engines are substantially more efficient than spark-ignited engines", generally; Harvey cites the side-by-side comparisons of Schipper et al. and the estimates of >20% lower fuel use and (given differences in energy content between fuel types) >15% lower energy use.[32] Gas turbine and some other types of internal combustion engines, and external combustion engine, both can also be designed to take diesel fuel.

The viscosity requirement of diesel fuel is usually specified at 40 °C.[22] A disadvantage of diesel as a vehicle fuel in cold climates, is that its viscosity increases as the temperature decreases, changing it into a gel (see Compression Ignition – Gelling) that cannot flow in fuel systems. Special low-temperature diesel contains additives to keep it liquid at lower temperatures, but starting a diesel engine in very cold weather may still pose considerable difficulties. Another disadvantage of diesel engines compared to petrol/gasoline engines is the possibility of diesel engine runaway failure. Since diesel engines do not need spark ignition, they can run as long as diesel fuel is supplied. Fuel is typically supplied via a fuel pump. If the pump breaks down in an "open" position, the supply of fuel will be unrestricted, and the engine will run away and risk terminal failure.[33]

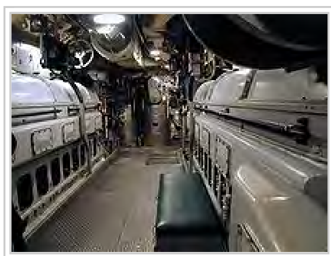
With turbocharged engines, the oil seals on the turbocharger may fail, allowing lubricating oil into the combustion chamber, where it is burned like regular diesel fuel. In vehicles or installations that use diesel engines and also bottled gas, a gas leak into the engine room could also provide fuel for a runaway, via the engine air intake.[34]

The crank case ventilation of modern road-use diesel engines is diverted into the intake manifold, because ventilating the crank case into outside air is inadvisable due to lubricant mist it contains. If the engine's piston rings malfunction, this will cause excessive pressure in the crank case forcing mist of engine lubricant into the intake manifold. Since most engines use oil which can be burnt in the same fashion as diesel, this will result in diesel engine runaway. To prevent that, more premium crank case ventilation solutions are fitted with a filter to catch out lubricant mist.

Most modern road use diesel engines are provided with an FRP valve in the intake manifold (usually mistaken by some as a petrol engine throttle body). In most basic applications this valve will close a flow of air mixture to the engine when the vehicle is switched off, preventing diesel engine runaway by starving the engine of oxygen; this will also make standard shutdown much smoother by eliminating compression and decompression rattle by making the pistons effectively work in vacuum. In more advanced control systems this FRP valve can be shut by an electronic control unit when it senses runaway scenario.

Trucks

Diesel fuel is widely used in most types of transportation. Trucks and buses, which were often gasoline-powered in the 1920s through 1950s, are now almost exclusively diesel-powered. The gasoline-powered passenger automobile is the major exception; diesel cars are less numerous worldwide.



Fairbanks-Morse opposed piston diesel engines on a submarine

Railroad

Diesel displaced coal and fuel oil for steam-powered vehicles in the latter half of the 20th century, and is now used almost exclusively for the combustion engines of self-powered rail vehicles (locomotives and railcars).[35][36]

Aircraft

The first diesel-powered flight of a fixed-wing aircraft took place on the evening of 18 September 1928, at the Packard Proving Grounds near Utica, Michigan. With Captain Lionel M. Woolson and Walter Lees at the controls the first "official" test flight was taken the next morning, flying a Stinson SM1B (X7654), powered by a Packard DR-980 9-cylinder diesel radial engine, designed by

Woolson. Charles Lindbergh flew the same aircraft and in 1929, it was flown 621 miles (999 km) nonstop from Detroit to Langley Field, near Norfolk, Virginia. In 1931, Walter Lees and Fredrick Brossy set the nonstop flight record flying a Bellanca powered by a Packard diesel for 84 hours and 32 minutes. *X7654* is now owned by Greg Herrick and is at the Golden Wings Flying Museum near Minneapolis, Minnesota.


Packard DR-980 9-cylinder diesel aircraft engine

Diesel engines for airships were developed in both Germany and the United Kingdom by Daimler-Benz and Beardmore produced the Daimler-Benz DB 602 and Beardmore Typhoon respectively. The LZ 129 Hindenburg rigid airship was powered by four Daimler-Benz DB 602 16-cylinder diesel engines, each with 1,200 hp (890 kW) available in bursts and 850 horsepower (630 kW) available for cruising.[37] The Beardmore Typhoon powered the ill-fated R101 airship, built for the Empire airship programme in 1931.

With a production run of at least 900 engines, the most-produced aviation diesel engine in history was probably the Junkers Jumo 205. Similar developments from the Junkers Motorenwerke and licence-built versions of the Jumo 204 and Jumo 205, boosted German diesel aero-engine production to at least 1000 examples, the vast majority of which were liquid-cooled, opposed-piston, two-stroke engines.

In the Soviet Union significant progress towards practical diesel aero-engines was made by the TsIAM (*Tsentral'nyy Institut Aviatsionnovo Motorostroyeniya* – central institute of aviation motors) and particularly by A.D. Charomskiy, who nursed the Charomskiy ACh-30 into production and limited operational use.[38]

Military vehicles

Armored fighting vehicles use diesel because of its lower flammability risks and the engines' higher provision of torque and lower likelihood of stalling.[39][40]

Cars

Diesel-powered cars generally have a better fuel economy than equivalent gasoline engines and produce less greenhouse gas emission.[41] Their greater economy is due to the higher energy per-litre content of diesel fuel and the intrinsic efficiency of the diesel engine.[42] While petrodiesel's higher density results in higher greenhouse gas emissions per litre compared to gasoline,[43] the 20–40% better fuel economy achieved by modern diesel-engined automobiles offsets the higher per-litre emissions of greenhouse gases, and a diesel-powered vehicle emits 10–20 percent less greenhouse gas than comparable gasoline vehicles.[44][45][46] Biodiesel-powered diesel engines offer substantially improved emission reductions compared to petrodiesel or gasoline-powered engines, while retaining most of the fuel economy advantages over conventional gasoline-powered automobiles.[44] However, the increased compression ratios mean there are increased emissions of oxides of nitrogen (NO_x) from diesel engines.[47] This is compounded by biological nitrogen in biodiesel to make NO_x emissions the main drawback of diesel versus gasoline engines.[47]

Tractors and heavy equipment

Today's tractors and heavy equipment are mostly diesel-powered. Among tractors, only the smaller classes may also offer gasoline engines. The dieselization of tractors and heavy equipment began in Germany before World War II but was unusual in the United States until after that war. During the 1950s and 1960s, it progressed in the latter country as well.

Tractors and heavy equipment were often multifuel in the 1920s through 1940s, running spark-ignition and low-compression engines. Thus many farm tractors of the era could burn gasoline, alcohol, kerosene, and any light grade of fuel oil such as diesel fuel, heating oil, or tractor vaporising oil, according to whichever was most affordable in any region at any given time. On U.S. farms during this era, the name "distillate" often referred to any of the aforementioned light fuel oils. The engines did not start as well on distillate, so typically a small auxiliary gasoline tank was used for cold starting, and the fuel valves were adjusted several minutes later, after warm-up, to switch to distillate. Engine accessories such as vaporizers and radiator shrouds were also used, both with the aim of capturing heat, because when such an engine was run on distillate, it ran better when both it and the air it inhaled were warmer rather than at ambient temperature. Dieselization with dedicated diesel engines (high-compression with mechanical fuel injection and compression ignition) replaced such systems and made more efficient use of the diesel fuel being burned.

Other uses

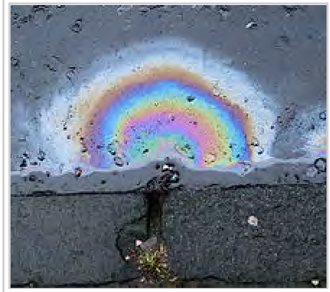
Poor quality diesel fuel has been used as an extraction agent for liquid–liquid extraction of palladium from nitric acid mixtures.[48] Such use has been proposed as a means of separating the fission product palladium from PUREX raffinate which comes from used nuclear fuel.[48] In this system of solvent extraction, the hydrocarbons of the diesel act as the diluent while the dialkyl sulfides act as the extractant.[48] This extraction operates by a solvation mechanism.[48] So far, neither a pilot plant nor full scale plant has been constructed to recover palladium, rhodium or ruthenium from nuclear wastes created by the use of nuclear fuel.[49]

Diesel fuel is also often used as the main ingredient in oil-base mud drilling fluid.[50] The advantage of using diesel is its low cost and that it delivers excellent results when drilling a wide variety of difficult strata including shale, salt and gypsum formations.[50] Diesel-oil mud is typically mixed with up to 40% brine water.[51] Due to health, safety and environmental concerns, Diesel-oil mud is often replaced with vegetable, mineral, or synthetic food-grade oil-base drilling fluids, although diesel-oil mud is still in widespread use in certain regions.[52]

During development of rocket engines in Germany during World War II J-2 Diesel fuel was used as the fuel component in several engines including the BMW 109-718.[53] J-2 diesel fuel was also used as a fuel for gas turbine engines.[53]

Chemical analysis

Chemical composition


Diesel does not mix with water.

Petroleum-derived diesel is composed of about 75% saturated hydrocarbons (primarily paraffins including *n*, *iso*, and cycloparaffins), and 25% aromatic hydrocarbons (including naphthalenes and alkylbenzenes).[54] The average chemical formula for common diesel fuel is $C_{12}H_{23}$, ranging approximately from $C_{10}H_{20}$ to $C_{15}H_{28}$.[55]

Chemical properties

Most diesel fuels freeze at common winter temperatures, while the temperatures greatly vary.[56] Petrodiesel typically freezes around temperatures of −8.1 °C (17.5 °F), whereas biodiesel freezes between temperatures of 2° to 15 °C (35° to 60 °F).[56] The viscosity of diesel noticeably increases as the temperature decreases, changing it into a gel at temperatures of −19 °C (−2.2 °F) to −15 °C (5 °F), that cannot flow in fuel systems. Conventional diesel fuels vaporise at temperatures between 149 °C and 371 °C.[22]

Conventional diesel flash points vary between 52 and 96 °C, which makes it safer than petrol and unsuitable for spark-ignition engines.[57] Unlike petrol, the flash point of a diesel fuel has no relation to its performance in an engine nor to its auto ignition qualities.[22]

Hazards

Reduction of sulfur emissions

In the past, diesel fuel contained higher quantities of sulfur. European emission standards and preferential taxation have forced oil refineries to dramatically reduce the level of sulfur in diesel fuels. In the European Union, the sulfur content has dramatically reduced during the last 20 years. Automotive diesel fuel is covered in the European Union by standard EN 590. In the 1990s specifications allowed a content of 2000 ppm max of sulphur, reduced to a limit of 350 ppm by the beginning of the 21st century with the introduction of Euro 3 specifications. The limit was lowered with the introduction of Euro 4 by 2006 to 50 ppm (ULSD, Ultra Low Sulfur Diesel). The standard currently in force in European Europe for Diesel Fuel is the Euro 5, with a maximum content of 10 ppm.

Emission standard	At latest	Sulfur content	Cetane number
Euro 1	1 January 1993	max. 2000 ppm	min. 49
Euro 2	1 January 1996	max. 500 ppm	min. 49
Euro 3	1 January 2001	max. 350 ppm	min. 51
Euro 4	1. January 2006	max. 50 ppm	min. 51
Euro 5	1 January 2009	max. 10 ppm	min. 51

In the United States, more stringent emission standards have been adopted with the transition to ULSD starting in 2006, and becoming mandatory on June 1, 2010 (see also diesel exhaust). U.S. diesel fuel typically also has a lower cetane number (a measure of ignition quality) than European diesel, resulting in worse cold weather performance and some increase in emissions.[58]

Environment hazards of sulfur

High levels of sulfur in diesel are harmful for the environment because they prevent the use of catalytic diesel particulate filters to control diesel particulate emissions, as well as more advanced technologies, such as nitrogen oxide (NO_x) adsorbers (still under development), to reduce emissions. Moreover, sulfur in the fuel is oxidized during combustion, producing sulfur dioxide and sulfur trioxide, that in presence of water rapidly convert to sulfuric acid, one of the chemical processes that results in acid rain. However, the process for lowering sulfur also reduces the lubricity of the fuel, meaning that additives must be put into the fuel to help lubricate engines. Biodiesel and biodiesel/petrodiesel blends, with their higher lubricity levels, are increasingly being utilized as an alternative. The U.S. annual consumption of diesel fuel in 2006 was about 190 billion litres (42 billion imperial gallons or 50 billion US gallons).[59]

Algae, microbes, and water contamination

There has been much discussion and misunderstanding of algae in diesel fuel. Algae need light to live and grow. As there is no sunlight in a closed fuel tank, no algae can survive, but some microbes can survive and feed on the diesel fuel.[60]

These microbes form a colony that lives at the interface of fuel and water. They grow quite fast in warmer temperatures. They can even grow in cold weather when fuel tank heaters are installed. Parts of the colony can break off and clog the fuel lines and fuel filters.[61]

Water in fuel can damage a fuel injection pump; some diesel fuel filters also trap water. Water contamination in diesel fuel can lead to freezing while in the fuel tank. The freezing water that saturates the fuel will sometimes clog the fuel injector pump.[62] Once the water inside the fuel tank has started to freeze, gelling is more likely to occur. When the fuel is gelled it is not effective until the temperature is raised and the fuel returns to a liquid state.

Road hazard

Petrodiesel spilled on a roadway poses a hazard to vehicles, due to its high evaporation temperature. After the light fractions have evaporated, a greasy slick is left on the road which can destabilize moving vehicles, causing them to skid. Diesel spills severely reduce tire grip and traction, and have been implicated in many accidents. The loss of traction is similar to that encountered on black ice. Diesel slicks are especially dangerous for two-wheeled vehicles such as motorcycles.

Further reading

- L. D. Danny Harvey, 2010, "Energy and the New Reality 1: Energy Efficiency and the Demand for Energy Services," London:Routledge-Earthscan, ISBN 1-84407-912-0, 672 pp.; see [3] (https://books.google.com/books?isbn=1844079120), accessed 28 September 2014.

See also

- Biodiesel
- H-Bio
- Common ethanol fuel mixtures
- Diesel automobile racing
- Diesel engine
- Dieselisation
- Gasoline gallon equivalent
- Hybrid vehicles
- Kerosene
- List of diesel automobiles
- Liquid fuels
- Turbodiesel
- *United States vs. Imperial Petroleum*
- Diesel exhaust

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References

1. Traders and importers now use the term, as well as academic journals for example ACS publications (See 2006 article (http://pubs.acs.org/doi/abs/10.1021/ef0502711) on comparing Petrodiesel emissions with other types of fuel). The term is common in blogs and informal wiki sites, and is used several times in this article itself.
2. "The UK oil industry over the past 100 years" (PDF). Department of Trade and Industry, UK Government. March 2007. p. 5. Archived from the original (PDF) on 4 March 2011.
3. The Macquarie Dictionary 3rd ed, The Macquarie Library 1997
4. DE 67207 (https://worldwide.espacenet.com/textdoc?DB=EPODOC&IDX=DE67207) Rudolf Diesel: "Arbeitsverfahren und Ausführungsart für Verbrennungskraftmaschinen" pg 4.
5. Alfred Philip Chalkley; Rudolf Diesel (1913). *Diesel Engines for Land and Marine Work*. Constable & Co. Ltd. pp. 4, 5, 7.
6. Ayhan Demirbas (2008). *Biodiesel: A Realistic Fuel Alternative for Diesel Engines*. Berlin: Springer. p. 74. ISBN 1-84628-994-7.
7. macCompanion Magazine (http://www.maccompanion.com/macc/archives/April2008/Greenware/K
8. Chris Collins (2007), "Implementing Phytoremediation of Petroleum Hydrocarbons, *Methods in Biotechnology* **23**:99–108. Humana Press. ISBN 1-58829-541-9.
9. "Synthetic Diesel May Play a Significant Role as Renewable Fuel in Germany". *USDA Foreign Agricultural Service website*. January 25, 2005. Archived from the original on 2006-09-27.
10. http://www.ecopar.se/files/pdf/syntetiska%20drivmedel%20vs%20mk1%20diesellolja.pdf
11. Bosch Automotive Handbook, 6th edition, p327-328
12. http://www.acea.be/images/uploads/070208_ACEA_FAME_BTL_final.
13. "Biodiesel: EU Specifications". World Energy.
14. "Biodiesel: ASTM International Specifications (B100)". World Energy.

15. http://www.greenintent.co.uk/Warrantee/scania.pdf
16. http://journeytoforever.org/biofuel_library/FIEM.pdf
17. http://altfuelsgroup.org/site/images/M_images/projects/b100overview.pdf
18. "Hempcar.org-Pollution: Petrol vs Hemp".
19. Bosch Automotive Handbook, 6th edition, p328
20. Warner, Emory (February 1997). "For safety sake, homestead fuel storage must be handled properly". *Backwoods Home Magazine* (43).
21. "Petroleum – frequently asked questions". *hse.gov.uk*. Health and Safety Executive. 6 December 2013. Retrieved 18 July 2014.
22. "Diesel fuel characteristics and resources". *ufa.com*. UFA. 2009. Retrieved 18 July 2014.
23. Table 2.1 (http://ies.jrc.ec.europa.eu/uploads/media/TTW_Report_010307.pdf)
24. "Facts about Diesel Prices".
25. "Gasoline and Diesel Fuel Update - Energy Information Administration".
26. http://www.eia.doe.gov/bookshelf/brochures/diesel/dieselprices2006.html
27. http://www.criterioncatalysts.com/static/criterion-gb/downloads/pdf/technical_papers/cri707ertc06.pdf
28. United States Government Printing Office (2006-10-25). "Title 26, § 48.4082–1 Diesel fuel and kerosene; exemption for dyed fuel.". *Electronic Code of Federal Regulations (e-CFR)*. Archived from the original on 2007-03-23. Retrieved 2006-11-28. "Diesel fuel or kerosene satisfies the dyeing requirement of this paragraph (b) only if the diesel fuel or kerosene contains— (1) The dye Solvent Red 164 (and no other dye) at a concentration spectrally equivalent to at least 3.9 pounds of the solid dye standard Solvent Red 26 per thousand barrels of diesel fuel or kerosene; or (2) Any dye of a type and in a concentration that has been approved by the Commissioner." Cited as 26 CFR 48.4082-1. This regulation implements 26 U.S.C. § 4082-1 (https://www.law.cornell.edu/uscode/text/26/4082-1).
29. http://www.eere.energy.gov/afdc/progs/ind_state_laws.php/TX/BIOD Texas Biodiesel Laws and Incentives
30. "North Carolina Biodiesel Laws and Incentives". Archived from the original on 2007-11-30.
31. See How Stuff Works [1] (http://auto.howstuffworks.com/diesel.htm) for an excellent explanation
32. L. D. Danny Harvey, 2010, "Energy and the New Reality 1: Energy Efficiency and the Demand for Energy Services," London:Routledge-Earthscan, ISBN 1-84407-912-0, p. 264, 267; see [2] (https://books.google.com/books?isbn=1844079120), accessed 28 September 2014.
33. Wellington, B.F.; Asmus, Alan F. (1995). *Diesel Engines and Fuel Systems*. Longman Australia. ISBN 0-582-90987-2.
34. "FIE system; diesel fuel system; boat fuel system".
35. Solomon, Brian; Yough, Patrick (15 July 2009). *Coal Trains: The History of Railroading and Coal in the United States (Google eBook)*. MBI Publishing Company. ISBN 0-7603-3359-9. Retrieved 9 October 2014.
36. Duffy, Michael C. (1 January 2003). *Electric Railways 1880–1990*. London: Institution of Engineering and Technology. ISBN 0-85296-805-1. Retrieved 9 October 2014.
37. "The Mercedes-Benz gasoline engine from 1926 on". Retrieved 8 June 2014.
38. Kotelnikov, Vladimir (2005). *Russian Piston Aero Engines*. Marlborough: The Crowood Press Ltd. ISBN 978-1-86126-702-3.
39. Tillotson, Geoffrey (1981). "Engines for Main Battle Tanks". In Col. John Weeks. *Jane's 1981–82 Military Annual*. Jane's. p. 59,63. ISBN 0-7106-0137-9.
40. Tillotson 1981, pp. 63
41. Nadel, Norman (11 May 1977). "Diesel Revival Is Going On in the Motor City". *The Argus-Press*. Detroit, Michigan. Retrieved 28 July 2014.
42. Hiereth, Hermann; Drexl, Klaus; Prenninger, Peter (4 November 2007). *Charging the Internal Combustion Engine*. Springer Science & Business Media. p. 233. ISBN 978-0-471-55878-1. Retrieved 28 July 2014.
43. "Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel". US Environmental Protection Agency. 2005.
44. "Greenhouse Gas Reductions". Diesel Technology Forum. Archived from the original on 2008-03-02. Retrieved 2008-03-13.
45. "Diesel cars set to outsell petrol". BBC News. October 23, 2002. Retrieved 2006-11-19.
46. "More Miles To The Gallon". Diesel Technology Forum. Archived from the original on 2006-09-27. Retrieved 2006-11-19.
47. "Alternative Transport Fuels – Courtesy of AIP". *world-petroleum.org*. World Petroleum Council. 2009. Retrieved 28 July 2014.
48. *Chemical Abstracts*. **110**. Washington D.C.: American Chemical Society. 13 March 1989. Retrieved 28 July 2014.
49. Torgov, V.G.; Tatarchuk, V.V.; Druzhinina, I.A.; Korda, T.M. *et al.*, *Atomic Energy*, 1994, **76**(6), 442–448. (Translated from Atomnaya Energiya; 76: No. 6, 478–485 (June 1994))
50. Neff, J.M.; McKelvie, S.; Ayers, RC Jr. (August 2000). Environmental Impacts of Synthetic Based Drilling Fluids (PDF) (Report). U.S. Department of the Interior Minerals Management Service. pp. 1–4. 2000-064. Retrieved 28 July 2014.
51. "Brines and Other Workover Fluids" (PDF). *GEKEngineering.com*. George E. King Engineering. 14 March 2009. Retrieved 28 July 2014.
52. Slumberger Oil Field Glossary, *diesel-oil mud*, http://www.glossary.oilfield.slb.com/Display.cfm?Term=diesel-oil%20mud
53. Price, P.R, Flight Lieutenant. "Gas turbine development by BMW" (PDF). Combined Intelligence Objectives Sub-Committee. Retrieved 7 June 2014.
54. Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological profile for fuel oils (http://www.atsdr.cdc.gov/toxprofiles/tp75-c3.pdf)*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service
55. Date, Anil W. (7 March 2011). *Analytic Combustion: With Thermodynamics, Chemical Kinetics and Mass Transfer (Google eBook)*. Cambridge University Press. ISBN 1-107-00286-9. Retrieved 9 October 2014.
56. National Renewable Energy Laboratory staff (January 2009). Biodiesel Handling and Use Guide (PDF) (Report) (Fourth ed.). National Renewable Energy Laboratory. p. 10. NREL/TP-540-43672. Retrieved 18 July 2014.
57. "Flash Point — Fuels". Retrieved January 4, 2014.
58. "Idle Hour," Feature Article, January 2005 (http://www.memagazine.org/backissues/membersonly/jan05/features/id
59. "U.S. Prime Supplier Sales Volumes of Petroleum Products".
60. "What is Diesel Fuel "ALGAE"?". *criticalfueltech.com*. Critical Fuel Technology, Inc. 2012. Retrieved 9 October 2014.
61. *Microbial Contamination of Diesel Fuel: Impact, Causes and Prevention* (Technical report). Dow Chemical Company. 2003. 253-01246.
62. AFS admin. "Water Contamination in Fuel: Cause and Effect - American Filtration and Separations Society".

External links

- U.S. Department of Labor Occupational Safety & Health Administration: Safety and Health Topics: Diesel Exhaust (https://www.osha.gov/SLTC/dieselexhaust/)

Retrieved from "https://en.wikipedia.org/w/index.php?title=Diesel_fuel&oldid=754486772"

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