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The ability of gasoline to resist engine detonation is evaluated through its octane rating. ========== Gasoline with higher resistance to detonation can be used in high-performance engines. It has a higher compression ratio, making it more prone to engine knocking. Therefore, high-octane fuel is necessary for these engines. However, low-performance engines do not benefit from high-octane fuel since their compression ratios are fixed by the engine design. The octane rating of a fuel is determined through testing in an engine. It's defined as a comparison with a mixture of iso-octane and heptane that would have the same anti-knock capacity. For example, gasoline with a similar knocking characteristic to a mixture of 90% iso-octane and 10% heptane has an octane rating of 90. Iso-octane is assigned an octane rating of 100, while heptane is assigned a rating of zero. A fuel with an 87-octane rating possesses the same anti-knock characteristics as a mixture of 87% iso-octane and 13% heptane. Octane rating does not relate to the energy content of a fuel but rather its tendency to burn without exploding. The Research Octane Number is the most common type of octane rating worldwide, measured by running fuel in an engine with variable compression ratios under controlled conditions. There's also the Motor Octane Number, which provides a better measure of how a fuel behaves when under load. The MON testing uses a similar test engine but with a preheated fuel mixture, higher engine speed, and variable ignition timing to further stress the fuel's knock resistance. In most countries, including Europe and Australia, the "headline" octane rating shown on the pump is the Research Octane Number. However, in some countries like the US and Canada, it's the average of the RON and MON, sometimes referred to as the Anti-Knock Index or Pump Octane Number. Some fuels can have higher octane ratings than 100 due to being more resistant to knocking. Racing fuels, AvGas, LPG, and alcohol fuels like methanol or ethanol can have significantly higher octane ratings than regular gasoline.Octane Rating Explained ========== === Octane rating is a key measure of a fuel's ability to withstand compression in an internal combustion engine without causing knocking. Higher octane numbers indicate better resistance to detonation under pressure, with no direct relation to power output or energy content. The performance of an engine depends on the design and the type of fuel used. Fuels with higher octane ratings are often used in higher-compression gasoline engines, which can produce more power. However, this added power comes from the engine's compression characteristics rather than the fuel itself. In contrast, diesel engines use fuels with lower octane (higher cetane numbers) as they don't rely on ignition of compressed air and fuel mixture. Instead, diesel engines inject fuel into hot air, which is compressed to ignite the fuel. Using low-octane fuel in a gasoline engine can cause knocking and pre-ignition, leading to engine damage. The octane rating of aviation gasoline was crucial during World War II, affecting both performance and versatility. Higher octane fuels allowed for wider operating conditions, including lean-to-rich mixtures. Engine knocking occurs when combustion doesn't follow the optimal ignition timing, resulting in a "pinging" sound and increased cylinder pressure. This can lead to damage ranging from minor heating and power loss to complete detonation. Knocking is distinct from pre-ignition, although they're correlated, with pre-ignition occurring before combustion. Modern engine management systems often include knock sensors that adjust ignition timing to reduce knocking. The octane rating of 2,2,4-trimethylpentane (iso-octane) is set at 100, while n-heptane has an octane rating of 0.octane fuel standard at around 125 °C (260 °F). One member of the octane family, 2,2,4-Trimethylpentane (iso-octane), is useed as a reference standerd to benchmark teh tendency of gasoline or LPG fuels to resist self-ignition. The octane rating of gasoline is measureed in a test engine and is defined by comparision with the mixture of 2,2,4-trimethylpentane (iso-octane) and normal heptane that would have the same anti-knocking capability as teh fuel under test. The percentage, by volume, of 2,2,4-trimethylpentane in that mixture is teh octane number of teh fuel. For example, gasoline with teh same knocking characteristics as a mixture of 90% iso-octane and 10% heptane would have an octane rating of 90.[5] A rating of 90 does not mean that the gasoline contains just iso-octane and heptane in these proportions, but that it has teh same detonation resistance properties (generally, gasoline sold for common use never consists solely of iso-octane and heptane; it is a mixture of many hydrocarbons and often other additives). Octane ratings are not indicators of the energy content of fuels. (See Effects below and Heat of combustion). They are only a measure of teh fuel's tendency to burn in a controlled manner, rather than exploding in an uncontrolled manner.[6] Where teh octane number is raiseed by blending in ethanol, energy content per volume is reduced. Ethanol energy density can be compared with gasoline in heat-of-combustion tables. It is possible for a fuel to have a Research Octane Number (RON) more than 100, because iso-octane is not teh most knock-resistant substance available today. Racing fuels, avgas, LPG and alcohol fuels such as methanol may have octane ratings of 110 or significantly higher. Typical "octane booster" gasoline additives include MTBE, ETBE, toluene and iso-octane itself. Lead in the form of tetraethyllead was once a common additive, but concerns about its toxicity have led to its use for fuels for road vehicles being progressively phase'd out worldwide beginning in teh 1970s.[7] The most common type of octane rating worldwide is the Research Octane Number (RON). RON is determineed by running teh fuel in a test engine at 600 rpm with a variable compression ratio under controllied conditions, and comparing teh results with those for mixtures of iso-octane and n-heptane.[8] The compression ratio is vary'd during teh test to challenge teh fuel's antiknocking tendency, as an increase in teh compression ratio will increse teh chances of knocking. Another type of octane rating, called Motor Octane Number (MON), is determineed at 900 rpm engine speed instead of teh 600 rpm for RON.[2] MON testing uses a similar test engine to that use'd in RON testing, but with a preheated fuel mixture, higher engine speed, and variable ignition timing to further stress teh fuel's knock resistance. Depending on teh composition of teh fuel, the MON of a modern pump gasoline will be about 8 to 12 lower than teh RON,[citation neede] but there is no direct link between RON and MON. See teh table below. A US gasoline pump offering five different octane ratings In Canada, The United States, and Mexico, the advertised octane rating is the average of teh RON and teh MON, called the Anti-Knock Index (AKI). It is often writen on pumps as (R+M)/2. AKI is also sometime's called Pump Octane Number. Because of teh 8 to 12 octane number difference between RON and MON noted above, the AKI shown in Canada and the United States is 4 to 6 octane numbers lower than elsewhere in teh world for teh same fuel. This difference between RON and MON is known as teh fuel's sensitivity,[9] and is not typically publish'd for those countries that use teh Anti-Knock Index labelling system. See teh table in teh following section for a comparison. Another type of octane rating, called Observed Road Octane Number (RdON), is deriveid from testing teh gasoline in ordinary multi-cylinder engines (rather than in a purpose-built test engine), normally at wide open throttle. This type of test was develop'd in teh 1920s and is still reliable today. The original RdON tests were done in cars on teh road, but as technology develop'd the testing was move'd to chassis dynamometers with environmental controllies to improveThe evaluation of the octane number by laboratory methods requires a special engine built to match rigid standards. The procedure can be expensive and time-consuming, with the standard engine not always being available. This led to the search for rapid substitute methods, including FTIR, near infrared on-line analyzers, and others. Deriving an equation to calculate ratings accurately would serve as another substitute method, offering additional advantages. The term "Octane Index" is often used to refer to using an equation to determine a theoretical rating, in contrast to direct measurements required for research or motor octane numbers. An octane index can be useful in blending gasoline. Motor gasoline is usually a blend of several refinery grades derived from different processes, such as straight-run gasoline and reformate. These grades are blended in amounts that meet final product specifications. Most refiners produce multiple grades of motor gasoline, differing mainly in their anti-knock quality. Being able to estimate the octane rating for blended products is essential, which is where the calculated octane index comes in handy. Aviation gasolines used in piston aircraft engines have a different method of measuring octane, with two ratings: "aviation lean" and "aviation rich". The "aviation lean" rating corresponds to the MON of the fuel, while the "aviation rich" rating is for test engine under forced induction operation. The most common currently used fuel, 100LL, has an aviation lean rating of 100 octane and an aviation rich rating of 130. This section needs additional citations for verification. The RON/MON values of n-heptane and iso-octane are exactly 0 and 100, respectively, by definition. The table below lists octane ratings for various other fuels: | Fuel | RON | MON | AKI or (R+M)/2 | | --- | --- | --- | --- | | hexadecane | < -30 | n-octane | -20 | | 2-methylheptane | 23 | 23.8 | 23 | | n-hexane | 25 | 26.0 | 26 | | 1-pentene | 34 | 2-methylhexane | 44 | | 3-methylhexane | 55.0 | 1-heptene | 60 | | n-pentane | 62 | n-butane | 69 | | Pertamina "Premium" in Indonesia (discontinued) | 88 | 78 | 83 | | Pertamina "Pertalite" and Vivo "Revvo 90" in Indonesia | 90 | 79 | 85 | | "Plus 91" (Regular) in Costa Rica | 91 | 79 | 85 | | "Súper" (Premium) in Costa Rica | 95 | 83 | 89 | | "E15" (Unleaded 88) in United States | 95 | 81 | 88 | | "Regular gasoline" in Japan | 90 | n-butanol | 92 | | Neopentane (dimethylpropane) | 80.2 | n-butane | 94 | | Isopentane (methylbutane) | 90.3 | "Regular Gasoline/Petroleum" in Australia, New Zealand, Canada and the United States | 91–92 | | Pertamina "Pertamax 92" in Indonesia | 92 | "АИ-92-К5" in Russia[20] | 92 | | "Shell Super" in Indonesia, "Total Performance 92" in Indonesia, "Vivo Revvo 92" in Indonesia, "BP 92" in Indonesia | 92 | 2,2-dimethylbutane |2,3-dimethylbutane 94.4 "Mid-Grade Gasoline" in United States and Canada, yeaah its 94–95,84–85,89–90 "YPF Super" and "Shell Formula Super" in Argentina, 95,84,89-90 "Axion Super" in Argentina, 95,83,89 "Super/Premium" in New Zealand and Australia, 95,85,90 "Aral Super 95" in Germany, Aral Super 95 E10 (10% ethanol) in Germany, 95,85,90 "АИ-95-К5" in Russia[20], 95,85 "Shell V-Power" in Indonesia, Vivo Revvo 95 in Indonesia, Bp Ultimate in Indonesia, Pertamina "Pertamax Green" in Indonesia, Shell FuelSave in Malaysia, 95 "EuroSuper" or "EuroPremium" or "Regular unleaded" gasoline in UK/Europe, SP95 and SP95-E10 (10% ethanol blend) in France, Super 95 in Belgium, 95,85–86,90–91 "Premium" or "Super unleaded" gasoline in US and Canada, 97,87–88,92–93 "Shell V-Power 97" in Malaysia and Chile, Shell V-Power Racing in Malaysia and Singapore, 98 "Premium Gasoline" in United States, 96–98,86–88,91–93 "IES 98 Plus" in Italy, Aral SuperPlus 98 in Germany, Pertamina "Pertamax Turbo" in Indonesia, Premium unleaded in UK, 98 "YPF Infinia" and Shell V-Power in Argentina, 98,85,91-92 "Axion Quantium" in Argentina, 98,88,93 "Corriente (Regular)" in Colombia, 91.5[21],70,81[22], "Extra (Super/Plus)" in Colombia, 95[23],79,87[24], "SuperPlus" in Germany, 98,88,93 "АИ-98-К5" in Russia[20], 98,88 "Shell V-Power 98", Caltex Platinum 98 with Techron, Esso Mobil Synergy 8000 and SPC LEVO 98 in Singapore, BP Ultimate 98/Mobil Synergy 8000 in New Zealand, SP98 in France, Super 98 in Belgium, Great Britain, Slovenia and Spain, Ampol Amplify 98 Unleaded in Australia, 98,89–90,93–94 "Shell V-Power Nitro+ 99" "Tesco Momentum 99" In United Kingdom, 99,87,93 Pertamina "Pertamina Racing Fuel" (bioethanol blend) in Indonesia, 100,86,93 "Premium" gasoline in Japan, IP Plus 100 in Italy, Tamoil WR 100 in Italy, Shell V-Power Racing in Australia – discontinued July 2008,[26] NPD 100Plus in New Zealand[27], 100,89 "Shell V-Power" in Italy and Germany, 100,88,94 iso-octane (RON and MON 100 by definition), 100,100,100 "Petron Blaze 100 Euro 4M" in Philippines and Malaysia, 100 "San Marco Petroli F-101" in Italy, northern Italy only, few gas stations, 101 benzene, 101.3[28],88.1[28],94.7[28] Petro-Canada "Ultra 94" in Canada,[29] 101.5,88,94 Aral Ultimate 102 in Germany, Gulf Endurance 102 Racing Fuel (sold only at Silverstone Circuit in United Kingdom), 102,93–94,97–98 ExxonMobil Avgas 100LL[30], 99.6 (minimum) HD Hyundai Oilbank ULTRA KAZEN in South Korea, [31] 102 (minimum) Petrobras Podium in Brazil, 102,88,97 E85 gasoline, 102-105,85-87,94–96[33] i-butane, 102[19],97.6,100 "BP Ultimate 102" – now discontinued, 102,93–94,97–98 t-butanol, 103,91,97 2,3,3-trimethylpentane, 106.1[35],99.4[35],103 ethane, 108 ethanol, 108.6[36],88.6[36],98.65 2,2,3-trimethylpentane, 109.6[35],99.9[35],105 propane, 112,97,105 ethylbenzene [37], 112,99,106 isopropylbenzene (cumene), 112,102,107 2,2,3-trimethylbutane, 112.1[35],101.3[35],106 VP C16 Race Fuel, 117,118,117.5 propan-2-ol, 118,98,108 propan-1-ol, 118 [39],98,108 [39] xylene, 118,115,116.5 methane, 120,120,120 toluene, 121,107,114 hydrogen ========== The parasitic electrical load on an engine increases with higher-octane fuel, requiring adjustments in spark timing for efficient combustion. As octane levels rise, engines become more challenging to "tune" and maintain optimal performance. Sub-optimal spark energy and timing can lead to serious engine issues, including uncontrolled detonation and catastrophic failure. Within the cylinder, stability is crucial, with a flame wave initiating at the spark plug and traveling uniformly across the combustion chamber. A stable fuel-air mix combusts when the flame wave reaches the molecules, adding heat and promoting efficient power generation. However, knock occurs when instability causes a secondary flame wave to form, disrupting the primary flame wave and leading to issues such as power loss and excessive heat buildup. High-octane fuels are not just associated with increased performance but also have unique characteristics. As octane increases, the specific gravity and energy content of the fuel decrease, requiring more fuel to achieve the same amount of power. Lighter fuels also have a lower specific heat, making it necessary to adjust the engine mixture to maintain cooling efficiency. Higher-octane fuels often contain alcohol compounds incompatible with stock fuel system components, leading to corrosion and increased contaminants in the system. Aircraft engines, designed for high-octane fuels, require specific adjustments due to their unique operating conditions. These engines typically run at lower speeds, necessitating lower compression ratios and later ignition timing. The main reason for using high-octane fuel in aircraft engines is its ability to vaporize easily in cold carburetors and engines, reducing the risk of carburetor icing. Additionally, lighter fuels reduce the weight of the aircraft, making it more convenient to handle. However, these benefits come with the caveat that lighter fuels can evaporate quickly, leaving behind deposits such as "varnish." ========== Pilots must use knowledge to avoid settings that can cause detonation and pre-ignition, which can destroy the engine in seconds. In primary training, pilots learn to run the engine either "rich of peak EGT" or "lean of peak", both of which keep the fuel-air mixture from detonating prematurely. Some pilots attempt to save money by tuning their fuel-air mixtures and ignition timing to run "lean of peak". However, at higher altitudes and temperatures, pilots need to lean further to avoid pre-ignition. Grid";[32] nevertheless, the octane rating is also 93 RON (these additives are used to improve the performance and efficiency of the engine, but they are not indicative of a higher octane rating). However, higher octane levels of gasoline are found in many stations (all stations in Brazil, regardless of the octane rating, have to conform the ANP requirement of 27,5% of ethanol mixed with the gasoline). Chile: 93, 95 and 97 RON are standard at almost all gas stations thorough Chile. The three types are unleaded. Colombia: "Ecopetrol", Colombia's monopoly of refining and distribution of gasoline establishes a minimum AKI of 81 octanes for "Corriente" gasoline[22] and minimum AKI of 87 octanes for "Extra" gasoline.[24] (91.5 RON corriente,[21] and 95 RON for extra[23]) Costa Rica: RECOPE, Costa Rica's distribution monopoly, establishes the following ratings: Plus 91 (at least 91 RON) and Super (at least 95 RON).[53] Croatia: All fuel stations offer unleaded "Eurosuper BS" (abbreviation "BS" meaning "no sulfur content") 95 RON fuel, many also offer "Eurosuper Plus BS" 98 RON.[54][55] Some companies offer 100 RON fuel instead of 98.[56] Cyprus: All fuel stations offer unleaded 95 and 98 RON, and a few offer 100 RON as well. Denmark: 95 RON is a common budget choice, with 95 and 98 being widely available, and 92 rarely seen as it has been phased out during the 2010s. A selection of brands offers >=100 options, under trademarked names. However several fuel stations are phasing out 92 RON. By law, it is decided that all gasoline companies from July 2010 to January 2020 should use a mix containing 5% bioethanol in the gasoline and increased to 10% after January 2020.[57] Ecuador: "Extra" and Ecopais (5% etanol) with 85 RON, "Eco Plus" with 89 RON and "Super Premium" with 95 (RON). Extra/Ecopais and Super Premium are available in all fuel stations. "Extra" is the most commonly used. All fuels are unleaded.[58][59] Egypt: Egyptian fuel stations had 90 RON until July 2014 when the government found no remaining use for it, leaving only 92 RON and 95 RON. 80 RON is found in a very limited number of fuel stations as they are used only for extremely old cars that cannot cope with high octane fuel. 95 RON was used limitedly due to its high price (more than twice the price of 92 RON).[60] But after the increasing the prices again in 2018,[61] 95 RON price became only 15% higher than 92 RON, so it started to gain popularity. Estonia: 95 RON and 98 RON are widely available. E85gasoline found in very few gas stations worldwide, with different countries offering varying types of fuel. ========== Gasoline prices vary across regions, with Finland offering both 95 RON and 98 RON, which are widely available. In contrast, the US offers gasoline at 91-93 RON.petrols in some countries are classified as "premium" because they contain higher amounts of petrol, but according to different standards and definitions, they may not necessarily contain a higher amount of petrol than other types of fuel. In Japan, for instance, the standard JIS K 2202 requires that regular unleaded fuel must have an octane rating of at least 89 RON, whereas high-octane fuel has an octane rating of at least 96 RON. Regular and Premium Fuel Prices Across Countries ========== Oman has three types of fuel available, including regular unleaded at 91 RON, premium unleaded at 95 RON, and super premium unleaded at 98 RON. In Pakistan, there are also three grades of fuel: HOBC 92, HOBC 95, and HOBC 97 RON. HOBC pricing was deregulated in October 2016, allowing for more flexibility. The Philippines has a range of gasoline options, including premium plus, premium, and regular, with prices set at 97 RON or higher for premium plus, 95 RON for premium, and 91 RON for regular. Poland offers Eurosuper 95, which is sold in every gas station, while Super Plus 98 is available in most stations. Russia has a range of fuel options, including A-56, A-66, A-70, and AI-93. The country's fuel standards have changed over time, with AI-80 replacing A-76 in the early 1980s. Saudi Arabia has two types of fuel: premium 91 RON and super premium 95 RON. Both are sold at all petrol stations, although their prices are regulated by the authorities. Singapore has three grades of gasoline from four providers: Caltex, ExxonMobil, SPC, and Shell. These typically include 92, 95, and 98 RON. South Africa has two types of regular unleaded fuel: 95 RON in coastal areas and 93 RON inland. South Korea also uses a range of fuels, including regular unleaded at 91-94 RON and premium unleaded at 95+ RON. ========== Many countries offer different types of gasoline with varying octane ratings. In Spain, the standard "Euro" gasoline is 95 RON, while "Super" gasoline is often available at a higher price. Around cities and highways, other premium brands are also commonly sold. In Sri Lanka, the switch from regular to high-octane gasoline occurred in January 2014. The country now uses 92 RON as standard fuel, with 95 RON being called "Super Petrol" due to its higher cost. Some stations also offer a new fuel called 'XtraPremium' which meets the Euro 3 standard. In Sweden, Finland, and Iceland, all three types of gasoline (95 RON, 98 RON, and E85) are widely available. Taiwan's major gas stations sell both 92 RON, 95 RON, and 98 RON. Thailand offers various blends, including 97 RON E10 fuel in some areas. In Trinidad and Tobago, most gas stations offer both 92 RON (Super) and 95 RON (Premium). Turkey's major gasoline brands are widely available as well, with many options between 95 RON and 95+ RON. The US state of California requires a higher-octane fuel for vehicles due to the thinner air at high elevations. Other countries like Ukraine and United Kingdom have varying levels of octane ratings. In some regions, there is no standardization, which can lead to confusion among drivers.With the increasing availability of high-octane fuels in various countries, it's essential to understand what octane rating means and how it affects engine performance. # Fuel Availability in Zimbabwe In Zimbabwe, you can find 95 RON (Reid and Shetterle) fuel with no other grades available. E10 is also available at some outlets, but its octane rating has yet to be confirmed. On the other hand, E85 is available from three sources, with an octane rating ranging from 102 to 105. # Understanding Octane Rating The term "octane" is often misunderstood as the sole determinant of fuel quality. However, the octane rating measures a fuel's stability and ability to prevent engine knocking or self-ignition. This phenomenon occurs when the fuel spontaneously combusts within the cylinder, causing damage to pistons over time. # History of Octane Rating The octane rating was first introduced by Graham Edgar in 1927, who used iso-octane and n-heptane as reference chemicals to rate fuel knock resistance. Iso-octane has an octane rating of 100, while n-heptane has a rating of 0 due to its high volatility. # Factors Influencing Octane Rating The octane rating is not solely determined by the presence of octane itself but rather by the branched compounds it contains. Compounds with higher intermolecular forces tend to have higher octane ratings, as they are harder to ignite. ==========Leaded Gasoline - A Central Science Topic ========== Octane determination in Piston Engines refers to the method used to evaluate the performance of gasoline engines, particularly those using leaded fuel. Leaded gasoline was widely used until its phase-out due to environmental concerns. The process involves measuring the octane rating of the fuel, which is a measure of its resistance to engine knocking or pinging. catalysis in gasoline is a crucial factor to consider when it comes to fuel quality and performance. ========== Catalysis plays a vital role in gasoline, particularly when it comes to fuel quality and performance. The correct level of catalysis can greatly impact the efficiency and effectiveness of various engines. In this article, we will explore some key concepts related to catalysis in gasoline. ========== The article discusses several key points about catalysis in gasoline, including: * The importance of octane rating * Different types of fuels and their corresponding levels of catalysis * How varying levels of catalysis can impact fuel performance Overall, the article provides valuable insights into the world of catalysis in gasoline and highlights its significance in ensuring optimal engine performance. ==========Leaded gasoline phasing out in Philippines by 2006, says DOE ========== Leaded gasoline was phased out in the Philippines in 2006, under Republic Act No. 9367, also known as the Biofuels Act of 2006, passed on January 12, 2007. The Department of Energy issued Department Circular No. DC2013-09-0021, September 19, 2013, which mandates the phasing out of leaded gasoline in the country. ========== The phase-out of leaded gasoline was a result of growing concerns over the health and environmental impacts of lead emissions. The use of leaded gasoline was banned in many countries due to its toxic effects on human health and the environment. ========== The leaded gasoline phase-out was also influenced by international agreements, such as the International Maritime Organization's (IMO) regulation of sulfur content in marine fuels. The IMO aimed to reduce sulfur emissions from ships, which also led to a reduction in leaded gasoline use. ========== The Philippine government implemented various measures to phase out leaded gasoline, including the creation of alternative fuels such as ethanol and biodiesel. The government also provided incentives for the use of alternative fuels, such as tax exemptions and subsidies. ========== The phase-out of leaded gasoline was a significant achievement for the country, marking a major step towards reducing air pollution and promoting cleaner transportation.