

FREQUENTLY ASKED QUESTIONS ABOUT ETHANOL

- What is fuel ethanol?

Ethanol is synonym with ethyl alcohol. Both terms refer to a type of alcohol consisting of two carbon atoms, five hydrogen atoms, and one hydroxyl group. As opposed to gasoline, ethanol is a pure substance consisting of only one type of molecule: C₂H₅OH. In ethanol production, however, it is necessary to distinguish anhydrous ethanol (or anhydrous ethyl alcohol) and hydrous ethanol (or hydrous ethyl alcohol). The difference lies in the water content of the ethanol grade: the water content of anhydrous ethanol is lower than 1 percent (approximately 99.3°GL). The hydrous ethanol that is sold at fuel stations has a water content of 7 percent (approximately 93°GL).

In the industrial production of ethanol, the hydrous grade is the one that comes directly from distillation tower. Producing anhydrous ethanol requires an additional processing stage that removes most of the water contained the fuel.

- How is fuel ethanol used in Brazil today?

Around 80 percent of Brazil's ethanol production is used as fuel, whereas 5 percent is used in foods, perfumes and alcohol chemicals, and 15 percent is exported.

Anhydrous ethanol is used in the production of 'C' gasoline, which is the only gasoline that can be marketed within Brazil's national territory for fueling motor vehicles. Fuel distributors purchase anhydrous ethanol from distilleries and 'A' gasoline (pure grade) from refineries, and then blend them at a rate that may range from 20 to 25 percent anhydrous ethanol. That means that fuel distributors are in fact the formulators of 'C' gasoline: they purchase two products on the market ('A' gasoline and anhydrous ethanol, which cannot be sold separately to end consumers) and produce a new gasoline grade, the 'C' gasoline, for consumption by vehicles.

Hydrous ethanol is used directly as a fuel for motor vehicles. It is the ethanol that consumers buy at the fuel station for vehicles that either run exclusively on ethanol or are equipped with “flex-fuel” engines. Consumers who own flex-fuel vehicles can also use hydrous ethanol exclusively.

- Is it true that ethanol has a negative energy balance, i.e. the energy we use to produce it (sugar-cane growing, transportation, industrial processing) is greater than the energy we get from the very ethanol for use in engines?

It is not true. That conclusion is a mistake that originates in analyses of the ethanol that is produced from corn in the USA. That is not the case of sugar-cane ethanol, such as the ethanol produced in Brazil.

In Brazil’s sugar-cane industry, the ratio between the renewable energy produced and the fossil energy used is 8.9 ethanol (2005). That figure is the highest among all liquid fuels produced from biomass around the world; the various biodiesel grades range from 2.0 to 3.0.

When corn ethanol is considered (as produced in the USA), that ratio ranges from 1.3 to 1.8; in fact, it was estimated at less than 1.0 (negative balance) a few years ago, at the beginning of the American program, but the processes have been gaining efficiency. For beet ethanol (such as that produced in Germany) or wheat ethanol (in some European countries), the ratio is approximately 2.0; sweet sorghum ethanol (estimates, in Africa) supposedly displays a ratio of 4.0. The main reason for the positive ratio provided by the Brazilian ethanol is because the sugar-cane industry does not use any fossil energy in the ethanol production process (only the sugar-cane bagasse is used). As a result, the production process (as well as the product) in Brazil features much greater sustainability than those of other countries. This fact, which is now well-known here, is becoming known out of Brazil as well, showing ethanol as an excellent fuel from an oil-saving stand point, as well as in terms of mitigation of greenhouse gas emissions.

- What do sugar-cane and ethanol represent in Brazil's energy base?

The use of ethanol as a fuel in Brazil reached 12 million cubic meters in 2005 (production amounted to 14.4 million cubic meters), representing around 40 percent of the fuels used in motor vehicles that year (Otto cycle). The sugar-cane agribusiness also generated 9.7 TWh of electric and mechanical power (drives), most of which having been consumed by itself (that is equivalent to 3 percent of all the electric power consumed in the country). The use of bagasse as a fuel was 17.5 M toe (tons of oil equivalent). In 2006, Brazil achieved self-sufficiency in oil, producing 1.8 to 1.9 million barrels a day (boe/day). Oil corresponds (2004) to 40.4 percent of the Production of Primary Energy in Brazil, with a strong share in transportation, the industrial sector, and non-energy uses.

Said self-sufficiency relies on the significant contribution provided by the sugar-cane industry, the share of which in the Production of Primary Energy reached 15.4 percent (2004). In 2005, the ethanol share was around 160,000 boe/day (13% of the total energy for transportation), and the amount of sugar-cane bagasse used as an industrial fuel (foods like sugar, citrus fruit and others) and in the energy sector (ethanol production) was around 410,000 boe/day. Of such amount, 63 percent is used directly as a fuel in the industrial sector (foods): 260,000 boe/day; in the industrial sector, the sugar-cane bagasse supplies as much energy as fuel oil and natural gas combined.

Therefore, even if the thermal energy produced from the sugar-cane bagasse for use in ethanol production (around 150,000 boe/day) were to be left out of account, the sugar-cane industry would still help to replace 420,000 boe/day worth of fuels (gasoline, fuel oil or natural gas) for the transportation and industrial sectors.

- Can ethanol be used in existing gasoline vehicles in other countries around the world?

Several experiences in several countries since the

1970's (Brazil, USA, Canada, Sweden, China, India, Thailand, Colombia, Jamaica, etc.) have successively demonstrated the technical feasibility of using ethanol-gasoline blends in vehicles (cars, pickup trucks, motorcycles, etc.) originally made to run on gasoline, requiring no change in the engine or the vehicle. Virtually all automakers in the world consider blends containing up to 10 percent ethanol to be acceptable. In fact, using blends is usually the fastest, most practical way of getting a fuel ethanol program started. Even though the ethanol content of the blend is mainly determined by the availability of the product and some economic and political factors, fuel specifications can also be a determining factor in this process.

In Brazil, the ethanol content of gasoline is higher than in other countries, ranging from 20 to 25 percent. Due to this characteristic, vehicles come out of the plant already prepared for that blend rate or, if imported, undergo the necessary adaptations (engine tuning and replacement of some components with other ethanol-compatible ones). It is important to point out that all of the gasoline distributed at the nation's fuel stations contains ethanol.

- What precautions are needed for using ethanol-gasoline blends in older vehicles in countries where that practice is not usual?

There is no impediment to the use of ethanol-gasoline blends in older vehicles. However, deposits of gasoline in the fuel supply system are usually found in those cases. Therefore, when ethanol-gasoline blends are used for the first time in older vehicles, it is advisable to make the first two fuel filter replacements at shorter intervals than usually recommended. Since it is a property of ethanol to clear the gasoline deposits, that practice prevents premature filter clogging and the resulting undesirable effects on the engine operation. Although most of the materials that have been used in vehicles for many years are compatible with the anhydrous ethanol that is added to gasoline, it is advisable to periodically check the condition of gaskets, plastic materials and metallic components that are directly in contact with the fuel in order to

ensure their integrity.

It is important for the ethanol that is added to gasoline to be the “anhydrous” grade and to have the quality characteristics that are appropriate for that kind of use. Where ethanol-gasoline blends are used, product quality specifications for both straight ethanol and blends containing ethanol are usually in place. Up-to-date Brazilian specifications can be found on the National Oil, Natural Gas and Biofuels Agency’s website (www.anp.gov.br).

- How are ethanol-gasoline blends prepared?

Ethanol and gasoline feature good miscibility, and it is relatively easy to prepare blends with them. The simplest method, which is extensively used in Brazil, is to blend them at the distributor’s plant as the tanker truck that will carry the product to the point of sale is filled up. The mixing process can be either manual, preferably by first pouring the desired volume of ethanol and then the gasoline, or automatic, at the very fuel line that fills up the tanker truck.

The mixing process requires the same caution and safety measure as used for handling any other fuels. It is important to prevent the mixture from being contaminated with water in order to avoid engine problems.

- Can ethanol be used alone as fuel?

Brazil has been the world’s major laboratory for the use of ethanol as a fuel, and more than 5 million vehicles specifically designed to run exclusively on ethanol have been manufactured in the country. Although ethanol has a lower energy content than straight gasoline (approximately 65%), it has several technical characteristics that make it perfectly suited for use as a fuel and partially make up for that lower energy content, such as the fuel’s high octane rating. In practice, vehicles that run exclusively on ethanol display a better performance (greater power and torque) and a longer service life than the gasoline-fueled equivalents. On the other hand, consumption increases by 20 to 30 percent in volume, depending on the characteristics of the

vehicle.

Compared to fossil fuels, ethanol provides more environmental benefits because the fuel vapors and gas emissions from the exhaust are less toxic, and also because the emission of carbon dioxide (CO₂), which accounts for most of the increase in the greenhouse effect, can be absorbed by sugar-cane through the photosynthesis process.

Based on the experienced gained from the use of exclusively ethanol-fueled vehicles, the fuel started to be used in aviation, as in the case of the IPANEMA alcohol-fueled agricultural aeroplane, which has been commercially produced by Embraer since 2004 (www.aeroneiva.com.br). Straight ethanol can also be used in flex-fuel engines, as well as in industrial facilities for generating thermal energy and electricity.

- What are "Flex-Fuel" vehicles?

They are vehicles equipped with an engine management system that can accurately identify the presence of gasoline and/or ethanol in the fuel tank, and then automatically adjust the engine operation accordingly. There are versions that use ethanol sensors, which are installed either in the tank or on the fuel line and are more common in the United States, while others identify the presence of ethanol through a sensor that measures the amount of oxygen contained in the exhaust gas, which is the system in place in Brazil.

In the USA and a few other countries like Canada and Sweden, vehicles run on both straight gasoline and on any blends with an ethanol content of up to 85 percent (E85) on non-winter days and 70 percent during the winter (E70). In Brazil, those vehicles run on gasoline, which contains 20 to 25 percent ethanol as it is, and any blends with higher ethanol contents, or even 100 percent ethanol (E100). This difference in the design of flex-fuel systems is determined by the characteristics of the fuels available in each country, the local climate, and whether or not auxiliary cold-start systems are available in vehicles.

A major advantage of the flex-fuel concept is that it enables the use of ethanol under limited infrastructural conditions for distributing the fuel,

as in the case of the United States. It also allows consumers to opt for the fuel of their choice, as in the case of Brazil.

The flex-fuel engine concept has also been adopted for hybrid vehicles that operate with a dual-motor system (an electric motor and an internal combustion engine), which further improves its ability to reduce emissions of CO₂ and other air pollutants.

- Why does ethanol arouse so much interest worldwide?

Today, the greater interest in the use of ethanol as an energy source results from the need to replace part of the oil that is used and reduce greenhouse gas emissions. The possibility to reduce the local pollution in urban centers by adding ethanol to gasoline, while improving gasoline quality thanks to the anti-knock power of ethanol, is also an important reason for such interest. The work carried out in Brazil is particularly important because it has demonstrated that very significant production levels can be attained at competitive costs.”