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Ethanol (Gasohol) From Corn to be used in Motor Vechils With Benzen

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ABSTRACT:

Bioethanol as a motor fuel in the transportation sector, mainly for road transportation, has been subject to many studies and much discussion. Furthermore, the topic involves not only the application and engine technical aspects, but also the understanding of the entire life cycle of the fuel, well-to-wheels, including economical, environmental, and social aspects. It is not, however, the aim of this report to assess every single one of these aspects. The present report aims to address the technical potential and problems as well as the central issues related to the general application of bioethanol as an energy carrier in the near future.

A suitable place to start studying a fuel is at the production stage, and bioethanol has been found to have a potential to mitigate greenhouse gases, depending on the production method. This and a potential for replacing fossil fuel-based oil (and being renewable) are the main reasons why ethanol is considered and implemented. Therefore, we must focus on two central questions related to ethanol implementation: how much carbon dioxide (CO_2) can be mitigated and how much fossil fuel can be replaced? A number of life cycle assessments have been performed in order to provide estimates. These assessments have generally shown that bioethanol has very good potential and can mitigate CO2 emissions very effectively, but It has also been shown that the potential for both fossil fuel replacement and CO2 mitigation is totally dependent on the method used to produce the fuel. Bioethanol can be made from a wide range of biomass resources, not all equally effective at mitigating CO2 emissions and replacing fossil fuel.

Keywords: Bioethanol, Corrosion, Environmental, Motor Fuel, Non-Pollutants, Road Transportation.

INTRODUCTION:

Fuel-grade ethanol, produced from biomass, has been considered as a suitable automotive fuel for nearly a century, particularly for vehicles equipped with spark-ignition engines (technically referred to as Otto cycle engines, but commonly known as gasoline engines). Ethanol was not used in significant amounts until the mid 1970s. The dramatic increase in the cost of oil at the time of the first oil crisis imposed severe foreign exchange burdens on countries dependent upon oil imports of sugar from sugarcane, situated to explore the option of ethanol as an alternative to gasoline. This led the Government to encourage the redirection of some sugarcane production to generate ethanol as a replacement for gasoline, thus reducing oil imports.

Overall, bioethanol represents the best alternative transportation fuel; its use is projected to increase significantly and remain high. As transportation fuel is a very big sector globally, a shift toward more bioethanol usage will potentially have great consequences in many areas of life, driving the need for more comprehensive evaluation methods and regulations. Among the concerns are the principles of sustainable development, particularly the need for the definition of indicators, regulations, and criteria; not unlike those implemented in the forestry sector. The most apparent problems in producing the biomass and then processing it to bioethanol are pollution and usage of water, use of fossil fuels in production, soil degradation, and land use conflicts. At the layman's level, perhaps the most intensely discussed concern to date has been the food versus fuel problem. Clearly, we should not deprive people of food in order to produce transportation fuels. As has been stated by the United Nations Food and Agriculture Organization, the problem at the present time seems not to be a lack of food production capability, but rather, economical politics namely, trade barriers. Aside from that, it has been discussed whether any real potential for greenhouse gas mitigation potential exists with the current forms of ethanol production, especially outside Brazil, since another greenhouse gas, nitrous oxide (N2O), seems to be emitted when the feedstock crops are grown. This gas is a very powerful greenhouse gas, about 300 times stronger than CO2. There have been investigations showing a negative potential; that is, bioethanol would be a greater contributor to global warming than regular fossil fuels (gasoline). Another very important issue is the conservation of the natural carbon reservoirs. When land is converted into farm land, there is a possibility of releasing more CO2 into the atmosphere than the biofuel would be able to mitigate, even over a long time.

Currently, much effort is being put in to solving the problems of the second-generation ethanol technology, the way of producing bioethanol from cellulosic biomass. There is wide agreement about the advantages of this technology, for example, the use of much cheaper feedstock, because several highly efficient (energy) crops can be used, as well as biomass waste such as straw and corn cobs. Another advantage is a very high efficiency, that is, a high yield per area of land used. Lately there has even been talk about using algae as feedstock, thereby avoiding land use conflicts. Nevertheless, many remain to be resolved before this technology can be used on a wider scale, mainly improvement of cost efficiency as well as process efficiency. Ethanol has been shown to suit different kinds of integrated production scenarios. In Brazil the processes of producing ethanol and power have now been integrated at many locations with success. Previously the excess biomass, that is, bagasse, was burned under open air rather than being converted to power. This has a significant effect on the overall efficiency of the fuel production. In the United States, massive corn-based ethanol production creates opportunities for production of animal feed. In Denmark integrated production of second-generation bioethanol, biogas, hydrogen, and solid fuel pellets has been demonstrated to be exceptionally efficient at utilizing the biomass waste product straw, as well as reusing process water. The idea behind this method is to imitate nature by reusing the waste products from one process as feed for another process. Yet another facility has demonstrated the integrated production of power, district heating, and first-generation and second-generation bioethanol.

The solid carbon that remains from the ethanol production is burned in an efficient power plant, which then supplies the ethanol process with cheap, low-grade steam. The fuel properties of ethanol differ from those of gasoline. Depending on the application, that is, the type of blend used or whether it is used neat, the vehicle needs special specifications for some parts to function properly. First, ethanol is hygroscopic, and an effort is required to avoid water contamination and the ensuing problems. Moreover, production methods favor a content of water, because water can be removed only to a certain degree by normal distillation (up to about 95percent purity), and then another relatively energy costly process removes the remaining water. This makes an argument for using the fuel containing some amount of water. Unfortunately, ethanol has poor blending properties when mixed with either diesel or gasoline, if the ethanol contains more than a very small amount of water. Phase separation occurs and can, in the worst-case scenario, make the fuel inapplicable or, in other cases, cause all kinds of fuel system and engine problems. These blending problems depend on ambient temperatures and the blending ratios of ethanol, gasoline, and water, and therefore determine the choice of technology for a particular region or country.

The worst blending problems occur when low-percentage-ethanol blends containing water are used in cold climates. Mid-and high-percentage blends can contain much more water, posing fewer problems, and in Brazil, ethanol containing 7 percent water is used widely. The strategy behind this Brazilian watery ethanol fuel is to minimize production costs, because less effort/energy is needed for removing water from the ethanol. Another issue related to cold climate markets is cold starting or, more precisely, engine start problems and excessive start-up emissions. These problems are related to the use of high-percentage-ethanol blends such as E85 and are even more pronounced using neat ethanol. Ethanol does not contain the light hydrocarbon compounds that make gasoline a relatively good fuel at cold ambient temperatures. The evaporative and flammability properties also contribute to this problem. Nevertheless, there are solutions to these problems. The evaporative properties are also problematic regarding safety and pollution of the environment. Ethanol is more flammable at conditions normally occurring in the fuel system of vehicles and can therefore pose a danger, but preventive measures can be taken. The evaporative properties and the chemical properties can in many cases cause high evaporative emissions from the fuel system, compared to gasoline application, and even higher emissions for diesel vehicles. However, this problem is worse for low-percentage-ethanol blends, and high percentage- ethanol blends and neat ethanol seem to offer improvement compared to gasoline (but not diesel).

In terms of engine technical possibilities, almost all ethanol is used in gasoline vehicles, because gasoline blends well with ethanol, compared to diesel. In Brazil ethanol application is mandatory in gasoline vehicles, with the use of E25 and E100. In Sweden the use of E85 is fairly widespread and in several other countries the use of E5 and E10 is mandatory. Further increases in ethanol applications are somewhat limited by the unfortunate properties of ethanol use in regular gasoline vehicles. The general limit for these vehicles is set at about 5–10 percent ethanol in gasoline. In the United States and Sweden, the flex fuel vehicles (FFVs) currently on the road are compatible with blends ranging from 0 to 85 percent ethanol content. These vehicles have demonstrated the technical feasibility of running on ethanol fuels with a high renewable content, without higher cost. Certainly, there are fuel compatibility issues, especially for older vehicles.

Corrosion and other types of damages can occur in the fuel system, ultimately resulting in engine failure. Ethanol fuels are therefore not recommended for vehicles made before 1986. Many experimental studies have confirmed that ethanol in gasoline engines increases engine (energy) efficiency, torque, and power compared to baseline gasoline tests, mainly because of a superior fuel octane rating. On the other hand, ethanol contains much less energy per liter of fuel, very often resulting in lower mileage. However, the engine efficiency has in some cases been improved to a degree; that is, mileage was improved compared to that for gasoline. There is little doubt that ethanol, especially high-percentage-ethanol fuels or neat ethanol. can improve the overall energy efficiency of the vehicle fleet.

In terms of current trends in engine development, ethanol appears to be a good candidate, complimenting these trends well, both for gasoline and diesel engines. Technologies such as downsizing, direct injection, increased pressure charging, and also advanced ignition strategies (homogeneous charge compression ignition [HCCI] and controlled auto-ignition [CAI]) are all compatible with ethanol. Tailpipe emissions from vehicles running on ethanol fuels are generally cleaner than those from gasoline. However, evaporative emissions generally seem worse for ethanol fuels, namely, low-percentage blends. Investigations and models have shown that ethanol application does improve the overall health impact of the so-called air toxics, that is, carcinogenic compounds such as benzene and butadiene, even though aldehyde emissions increased with ethanol Ethanol can be applied in diesel vehicles with some limitations. In general, ethanol does not mix well with diesel oil, but with the use of additives, ethanol can be used more or less immediately. With the use of biodiesel (fatty acid methyl esters [FAME]), ethanol has been shown to blend quite well with diesel, thus representing a fuel with a potential for a high degree of renewability, easily up to 30 percent. Neat ethanol has been used in diesel engines, improving the tailpipe emissions significantly. Even relatively small amounts of ethanol seem to improve the emissions of particulate matter. Questions remain, however, about the impact of ethanol on the size of the particulate and emission reduction systems. Many types of application techniques have been tried with relatively high degrees of success, making it possible to apply ethanol in diesel vehicles.

Again, ethanol seems to suit engine development trends. Ethanol promotes a higher tolerance for engine gas recirculation ratios, which reduces nitrogen oxides (NOx) emissions. The lower emissions of particulate matter make it possible to reduce NOx further, and ethanol can also be used in future HCCI engines.

SECURITY OF FUEL SUPPLY

Fossil oil reserves are predicted to be limited, and they will be fading at some point in the future, if not already. Recent dramatic fluctuations in oil prices indicate a steadily increasing demand. The time horizon for oil depletion is very difficult to predict, but it is quite certain that the supply/demand situation will worsen as time passes. It is likely that the oil price will rise significantly in the coming decades, possibly with very dramatic impacts on all levels of society. At some point it will makes much less economical sense to fuel cars with fuels produced from fossil oil, because it will be cheaper to produce fuel from other sources, such as coal, gas, biomass, wind or water energy, or even nuclear power. Ethanol offers an immediate possibility to reduce the dependency on fossil oil, and this is perhaps the most important reason for using ethanol in the transportation sector today. If ethanol is chosen as part of the solution to the problem of fading oil reserves, it is important to ensure a sustainable ethanol production that can satisfy the need continuously.

ETHONAL FROM CORN:

Ethanol is the systematic name defined by the IUPAC nomenclature of organic chemistry for a molecule with two carbon atoms (prefix "eth-"), having a single bond between them (suffix "-ane"), and an attached -OH group (suffix "-ol"). Ethanol is a 2-carbon alcohol with the molecular formula CH_3CH_2OH. Its empirical formula is C_2H_6O. An alternative notation is CH_3–CH_2–OH, which indicates that the carbon of a methyl group (CH_3–) is attached to the carbon of a methylene group (–CH_2–), which is attached to the oxygen of a hydroxyl group (–OH). It is a constitutional isomer of dimethyl ether. Ethanol is often abbreviated as **EtOH**, using the common organic chemistry notation of representing the ethyl group (C_2H_5) with **Et**.

Ethanol was first prepared synthetically in 1825 by Michael Faraday. He found that sulfuric acid could absorb large volumes of coal gas. He gave the resulting solution to Henry Hennell, a British chemist, who found in 1826 that it contained "sulphovinic acid" (ethyl hydrogen sulfate). In 1828, Hennell and the French chemist Georges-Simon Sérullas independently discovered that sulphovinic acid could be decomposed into ethanol. Thus, in 1825 Faraday had unwittingly discovered that ethanol could be produced from ethylene (a component of coal gas) by acid-catalyzed hydration, a process similar to current industrial ethanol synthesis. Ethanol was used as lamp fuel in the United States as early as 1840, but a tax levied on industrial alcohol during the Civil War made this use uneconomical. The tax was repealed in 1906. Original Ford Model T automobiles ran on ethanol until 1908. With the advent of Prohibition in 1920, ethanol fuel sellers were accused of being allied with moonshiners, and ethanol fuel fell into disuse until late in the 20th century. In modern times, ethanol intended for industrial use is also produced from ethylene. Ethanol has widespread use as a solvent of substances intended for human contact or consumption, including scents, flavorings, colorings, and medicines. In chemistry, it is both an essential solvent and a feedstock for the synthesis of other products. It has a long history as a fuel for heat and light, and more recently as a fuel for internal combustion engines.

Table 1: Energy content of some fuels compared with ethanol

Fuel type	**MJ/L**	**MJ/kg**	**Research octane number**
Dry wood (20% moisture)		~19.5	
Methanol	17.9	19.9	108.7
Ethanol	21.2	26.8	108.6
E85 (85% ethanol, 15% gasoline)	25.2	33.2	105
Liquefied natural gas	25.3	~55	
Autogas (LPG) (60% propane + 40% butane)	26.8	50.	
Aviation gasoline (high-octane gasoline, not jet fuel)	33.5	46.8	100/130 (lean/rich)
Gasohol (90% gasoline + 10% ethanol)	33.7	47.1	93/94
Regular gasoline	34.8	44.4	min. 91
Premium gasoline			max. 104
Diesel	38.6	45.4	25
Charcoal, extruded	50	23	

Complete combustion of ethanol forms carbon dioxide and water vapor:

C_2H_5OH (l) + 3 O_2 (g) → 2 CO_2 (g) + 3 H_2O (g); ($\Delta H_c = -1371$ kJ/mol) specific heat = 2.44 kJ/(kg·K)

Ethanol for use in alcoholic beverages, and the vast majority of ethanol for use as fuel, is produced by fermentation. When certain species of yeast (e.g., Saccharomyces cerevisiae) metabolize sugar they produce ethanol and carbon dioxide. The chemical equations below summarize the conversion:

$$C_6H_{12}O_6 \rightarrow 2\ CH_3CH_2OH + 2\ CO_2$$

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 4\ CH_3CH_2OH + 4\ CO_2$$

Fermentation is the process of culturing yeast under favorable thermal conditions to produce alcohol. This process is carried out at around 35–40 °C. Toxicity of ethanol to yeast limits the ethanol concentration obtainable by brewing; higher concentrations, therefore, are usually obtained by fortification or distillation. The most ethanol-tolerant strains of yeast can survive up to approximately 15% ethanol by volume. To produce ethanol from starchy materials such as cereal grains, the starch must first be converted into sugars. In brewing beer, this has traditionally been accomplished by allowing the grain to germinate, or malt, which produces the enzyme amylase. When the malted grain is mashed, the amylase converts the remaining starches into sugars. For fuel ethanol, the hydrolysis of starch into glucose can be accomplished more rapidly by treatment with dilute sulfuric acid, fungally produced amylase, or some combination of the two.

Sugars for ethanol fermentation can be obtained from cellulose. Until recently, however, the cost of the cellulase enzymes capable of hydrolyzing cellulose has been prohibitive. The Canadian firm Iogen brought the first cellulose-based ethanol plant on-stream in 2004. Its primary consumer so far has been the Canadian government, which, along with the United States Department of Energy, has invested heavily in the commercialization of cellulosic ethanol. Deployment of this technology could turn a number of cellulose-containing agricultural by-products, such as corncobs, straw, and sawdust, into renewable energy resources. Other enzyme companies are developing genetically engineered fungi that produce large volumes of cellulase, xylonite, and hemicellulase enzymes. These would convert agricultural residues such as corn stover, wheat straw, and sugar cane bagasse and energy crops such as switchgrass into fermentable sugars. Cellulose-bearing materials typically also contain other polysaccharides, including hemicellulose. When undergoing hydrolysis, hemicellulose decomposes into mostly five-carbon sugars such as xylose. *S. cerevisiae*, the yeast most commonly used for ethanol production, cannot metabolize xylose. Other yeasts and bacteria are under investigation to ferment xylose and other pentoses into ethanol. On January 14, 2008, General Motors announced a partnership with Coskata, Inc. The goal was to produce cellulosic ethanol cheaply, with an eventual goal of US$1 per US gallon ($0.30/L) for the fuel. The partnership planned to begin producing the fuel in large quantity by the end of 2008, and by 2011 to have a full-scale plant on line, capable of producing 50 million US gallons (190,000 m^3) to 100 million US gallons (380,000 m^3) of ethanol a year (200–400 ML/a). In October 2011, an article on the Coskata website stated that a "semi-commercial" pilot plant in Madison, Pennsylvania, had been running successfully for 2 years and that a full scale facility was planned for Alabama.

Ethanol is the largest biofuel in the world and is expected to remain so. Figure 1 shows how ethanol accounts for a relatively small fraction of the total fuel demand globally. The main suppliers of ethanol are the United States and Brazil. First, a continued massive increase in ethanol production and usage will have tremendous effects on the people, economy, and ecosystems of the planet. The IEA projects an average annual growth rate of 6.3 percent for consumption of liquid biofuels from 2005 to 2030, most of that being ethanol. Second, an increasing dependency on the fuel will demand reliable production. Therefore, growing of the feedstock crops used for ethanol production must done in a sustainable way.

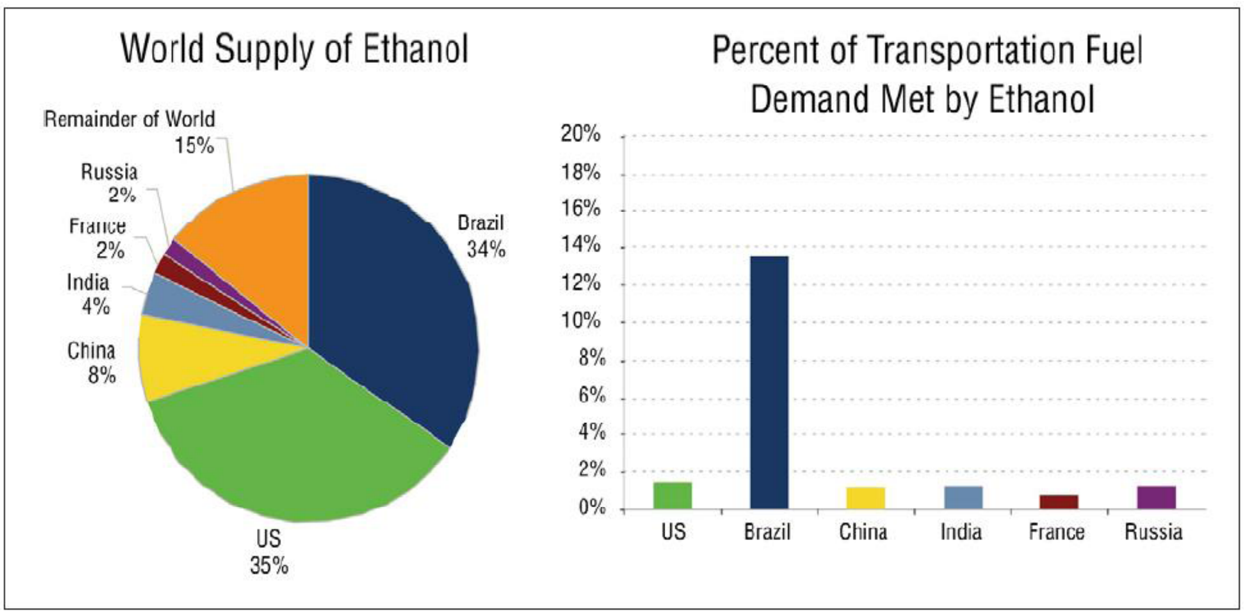

Figure 1: World Supply and Demand Met Figures

Sustainability, according to findings reported at the Rio Conference 1992, includes economical, social, and ecological concerns, and it seems necessary to consider all three concerns when deciding whether to use ethanol as a motor fuel extensively. According to the Brundtland report definition of sustainability (1987), sustainable ethanol must provide a solution that ”satisfies the needs of today without compromising the needs of future generations.” Economics strongly influences the technical solutions a community or region chooses and thus influences the environment in different ways. At present, it makes more economical sense to keep producing ethanol using first-generation technology, even though the actual GHG gas mitigation and emission benefits in some cases seem rather limited. Socially there are heated discussions, at many levels around the world, about the food or fuel issue, but other issues such as regional agricultural development and international trade relations are also important. In terms of ecosystems, the discussions concern topics such as the need to preserve valuable ecosystems, for example, the Amazon rainforests of Brazil, and to ensure the quality of local soil and water.

Technical characteristics of ethanol as a fuel

Ethanol is an excellent motor fuel. It has a motor octane number of 98 which exceeds that of gasoline (octane number of 80). It also has a lower vapor pressure than gasoline, which results in lower evaporative emissions. Ethanol's flammability in air is also lower than that of gasoline which reduces the number and severity of vehicle fires. Anhydrous ethanol has lower and higher heating values of 21.2 and 23.4 MJ/liter, respectively; for gasoline the values are 30.1 and 34.9 MJ/liter.

On the basis of higher heating value, ethanol has only 67% of the energy content compared with the same volume of gasoline. However, since it has a motor octane number higher than gasoline, it can be used in engines with a higher compression ratio (12-to-1, compared with the 8-to-1 ratio typically found in gasoline-fueled engines). As a result, ethanol-fueled engines are approximately 15% more efficient than motors using gasoline, which compensates to some extent for the lower energy content per unit volume. Typically, one would require approximately 20% more ethanol than gasoline per kilometer driven.

In ethanol was used initially in one of two ways:

• Blended as an octane enhancer in gasoline; typical blends range from 20% to 25% anhydrous (a mixture called gasohol; anhydrous ethanol is 99.6% ethanol Gay-Lussac (GL) which express the percentage of alcohol in a blend) and 0.4% water; ethanol in fuel by volume, or

• On its own, in neat-ethanol engines; used in the form of hydrous ethanol at 95.5 GL.

Ethanol's properties (as a fuel) have led to the development of dedicated engines for neat ethanol in Brazil. Initial efforts were conducted by the Centro de Tecnologia Aeronáutica (CTA) in São Paulo state, where most of the tests with engines running with ethanol-gasoline blend and straight ethanol were performed up to 1980. In the early 1980s, vehicles with neat-ethanol engines that could use hydrous ethanol became highly attractive to consumers, as the government had ensured the pump price of hydrous alcohol would be equivalent to 64.5% of the gasoline price. Sales of neat-ethanol powered vehicles exploded, and the market share occupied by these vehicles increased to more than 90% of all vehicle sales. The total fleet of neat-ethanol fueled vehicles at one point reached 5 million. Most of the service stations were equipped with two reservoirs (one for anhydrous ethanol, and the other for ethanol-gasoline blends at 20% to 25% ethanol). The lack of a guarantee of ethanol production to supply this expanding market became a critical issue, and in the early 1990s a shortage in ethanol production led to a serious crisis and a gradual abandonment of the use of neat-ethanol driven cars. There were other problems associated with neat-ethanol vehicles, including the problem of not being able to use them in neighboring countries or in regions of Brazil which did not have service stations capable of supplying pure ethanol.

The introduction of flex-fuel motors in Brazil, in 2003, solved this problem, since they are capable of running with blends from E0 to E100. The technology is based on sensors in the fuel system that automatically recognizes the ethanol level in the fuel. The engine's electronic control unit then self-calibrates for the best possible operation; if ethanol is not present, the engine will self-calibrate to gasoline-only operation. The process is instantaneous and undetectable by the vehicle driver.

Net Energy Value and Greenhouse Gasses

One of the main reasons for using biofuels, including ethanol, is to reduce GHG emissions. GHGs are gasses that impair the earth’s ability to radiate thermal energy to space. The amount of GHGs in the atmosphere is depends on the circulation of carbon; that is, the amount of carbon is relatively constant. Important GHGs are CO_2, methane (CH_4), nitrous oxide (N_2O), and water vapor. In order to assess GHG potentials, the term of measure CO_2

equivalent (CO2eq) is used to express the amount of global warming potential as an equal amount of CO2.

The CO2eq's for methane and nitrous oxide are 23 and 296, respectively, meaning methane has a 23 times stronger GHG potential than CO2. 3 The term CO2-neutral is sometimes used to describe ethanol, but the term is misleading, because production of ethanol at present cannot be done without introducing fossil-based CO2 or other GHGs into the atmosphere. Currently there is a great deal of debate on whether usage of ethanol in the transportation sector really reduces GHG emissions. The predominant tool used to assess this is LCA or, in fuel terms, a well-to-wheels (WTW) assessment. In this case WTW assessments most often aim at estimating the net output of GHGs and usage of fossil fuels by accounting for various inputs and outputs associated with the entire life cycle of a given fuel. An often used, but also criticized, term for evaluating ethanol is the net energy value (NEV). NEV is defined as the difference in energy content between the fuel product (output) and the energy used to produce it (input). A more relevant way of evaluating ethanol is to compare only the non-renewable, or fossil fuel, input used with output energy.

Evaporative Emissions

A common critique of ethanol fuels is that although use of ethanol fuels often improves tailpipe emissions, it increases evaporative emissions. However, this is not necessarily correct. Evaporative emissions from the entire vehicle have been the subject of increased research in recent years. The focus is on emissions of VOC, which are hydrocarbons that evaporate from the vehicle. The rate of evaporation is strongly related to the RVP of the fuel. The vapor pressure of ethanol–gasoline blends.

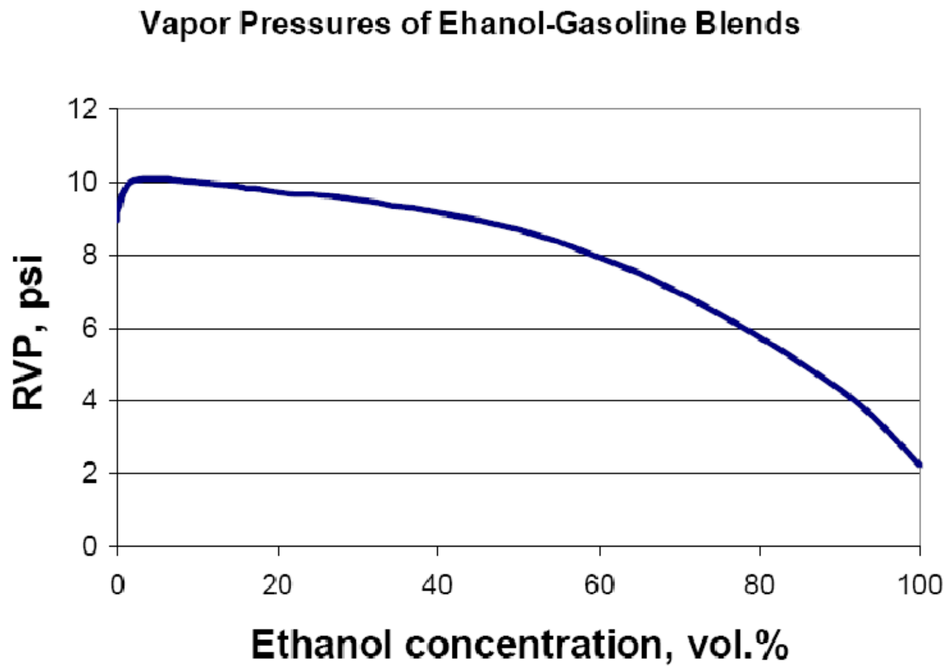

Figure 2: Vapor Pressure of Ethanol/Gasoline Blends

The figure shows how low ethanol levels increase the RVP of ethanol–gasoline fuels having a maximum of 5 to 10 percent ethanol. The RVP can vary depending on the composition of the base gasoline fuel blend stock. Ethanol itself has a lower RVP than gasoline, so ethanol would be expected to always lower the RVP in a gasoline blend.

The reason for the initial increase in RVP of low-level ethanol–gasoline blends is that ethanol forms azeotropic phases with some of the HC of the gasoline, resulting in very low boiling points for these phases. In practice, however, E10-type blends generally do not have a higher vapor pressure than pure gasoline, because manufacturers deliberately avoid the problem by using less volatile gasoline for mixing with ethanol, in order to meet the specified limit for vapor pressure of fuels. However, when mixing E10 and pure gasoline, the act of filling up the fuel tank could conceivably lead to the formation of E5 blend with a vapor pressure above the specified limit. To guard against this possibility, fuels must be formulated with a sufficient margin to the specified vapor pressure limits. Evaporative emissions can be divided into four types: (1) permeation of fuel components through fuel system components of vehicles, (2) leaks of liquid, vapor, (3) fuel tank venting canister losses, and (4) evaporative emissions associated with refueling. of vehicles.

Leaks are relatively easily to deal with by regular vehicle maintenance. Although the vapor pressure of ethanol fuels can be adjusted to levels of regular gasoline, studies suggests that this not the deciding factor in relation to permeation; it depends on ethanol content. Increased HC permeation due to ethanol fuels is not fully understood, but positive results with reducing these emissions have been obtained in, for example, low-emission vehicles (LEVs) and partial zero-emissions vehicles (PZEVs). As reported in the literature, low-percentage ethanol blends, 5–10 percent, tend to increase permeation, while high-percentage blends, mainly E85, seem to cause lower emissions compared to regular gasoline. Literature reports on permeation data using mid-percentage ethanol fuels (E20–E70) have not been found.

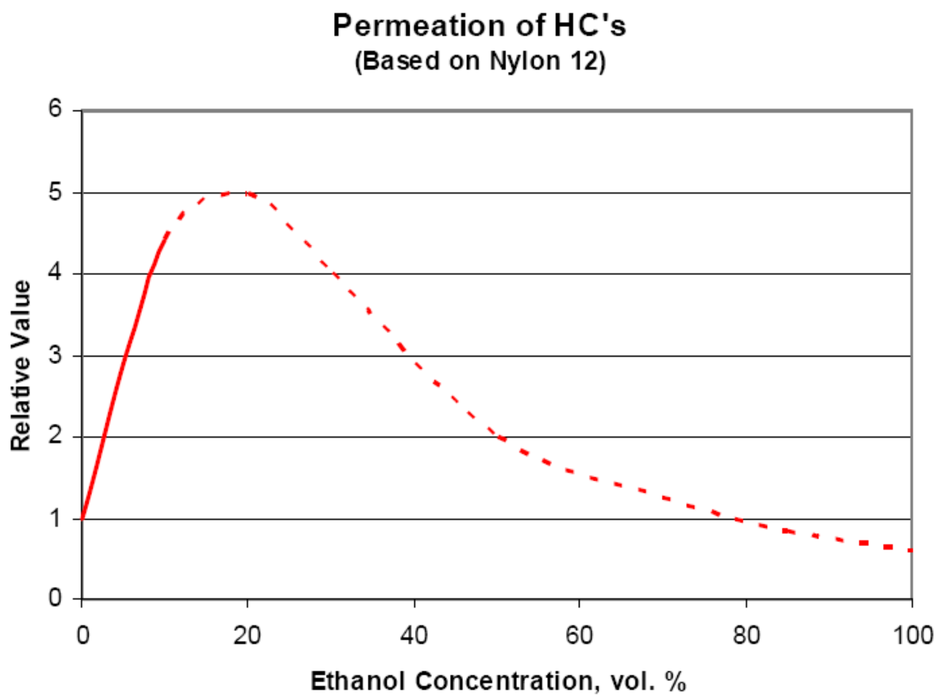

Figure 3: Permeation of Hydrocarbons

A part of the evaporative emissions are stopped by the carbon canister. Fuel vapors within the fuel system of vehicles are circulated through the canister containing activated carbon, which absorbs fuel vapors while the engine is not running and releases these vapors into the engine when it is running, purging the filter. Unfortunately ethanol seems to be prone to accumulate in the canister, compromising efficiency. Studies have found that it is very difficult to remove the ethanol from the canister, even when running on normal gasoline. It is not clear how long term or to exactly what degree canister efficiency is reduced. It might depend on the individual model design and fuel type. Because of this phenomenon, ethanol usage indirectly results in increased VOC emissions longer than ethanol is actually used in the vehicle.

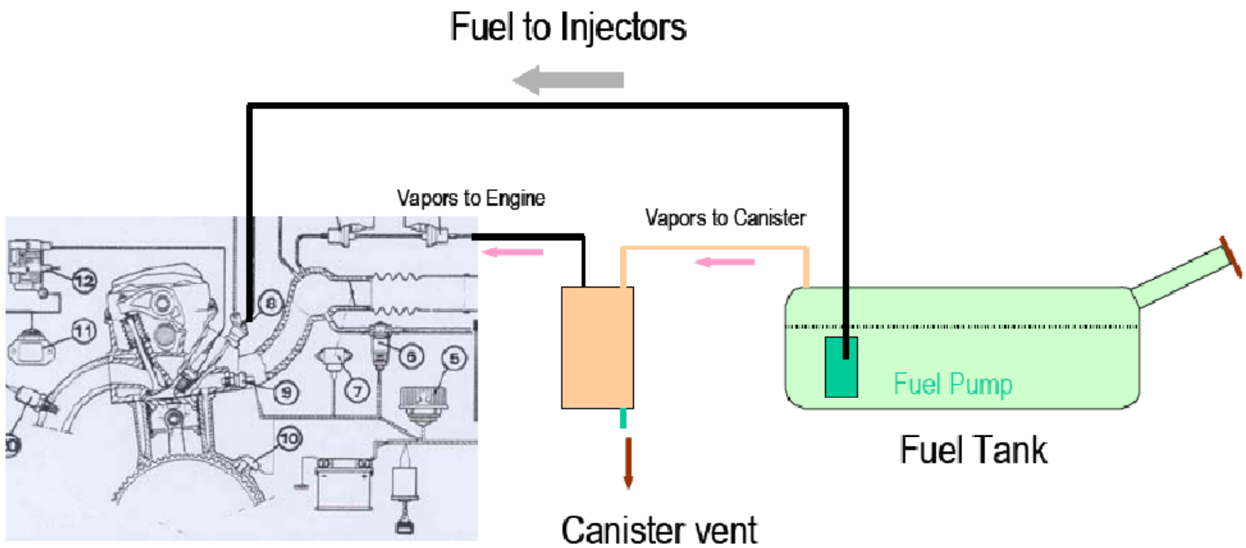

Figure 4: Evaporative Emissions Control System

Evaporative emissions were investigated in Sweden in 2006 and found to be as significant as up to one-third of the total emissions from all road traffic in Sweden. Out of 50 cars tested, 20 exceeded the limit set by an EU directive. The cars were between 6 months and 5 years old and had been driven 15.000–80.000 km. The limit was in some cases exceeded by 20 times the limit value. A study of the effects of using E20 in the Australian fleet showed that evaporative emissions for E20 would be equal to or in some cases less than those for gasoline. The more recent 2008 Australian study found that evaporative emissions of acid aldehydes such as acetaldehyde and formaldehyde increased with the use of E5 and E10 compared to gasoline. Total hydrocarbons also increased with E5 and E10 blends. Evaporative emissions of alcohols were influenced by individual vehicle factors that are likely to depend on the design of vapor canisters of the vehicles. Another comprehensive study of seven modern European vehicles was made for the European Commission by CONCAWE/EUCAR/JRC. The fuels tested were splash-blended E5 and E10 fuels with unadjusted RVP values and E5 and E10 with RVP adjusted to meet standard values. Results showed that evaporative emissions from the vehicles depended strongly on the vapor pressure of the fuel. The tests did not show any specific connection between ethanol content and evaporative emissions at the same RVP. This lack of ethanol effect is supported by Soloman's findings. which indicated that the emissions were mainly due to canister losses and not permeation.

Serious issues remain to be solved when using low-percentage ethanol–gasoline blends. Because emissions from vehicles are under increasingly stringent regulations, this issue might pose a hurdle for E5 and E10 blends especially. However, problems do seem solvable, particularly for the Californian LEV and PZEV vehicles. The Australian study on the health impacts of ethanol blend fuel selected a representative sample of vehicles from the current Australian fleet and compared actual emissions (exhaust and evaporative) from E5, E10. and gasoline (ULP). Emissions data were used to model the Sydney urban airshed under different scenarios, for example, all vehicles using E10, to determine the potential health impacts on the population.

The results of this study were as follows:

- Emissions from E5 and E10 showed that the levels of some pollutants such as NOx and aldehydes, marginally increased, while other emissions, such as PM, CO, and benzene, decreased.
- PM2.5 emissions from tailpipe tests showed an average 19 percent decrease with E5 use and an average 33 percent decrease with E10 use.
- Increases in population exposure were seen for ozone for all E5 and E10 scenarios and for NO2 for the E10 scenarios.
- A total of 97 percent of potential health cost savings were due to decreases in PM-related mortality. Potential health cost savings would be reduced over time as newer vehicles with advanced emission control systems replaced older vehicles.

CONCLUSION:

Ethanol has a number of unique properties that make it a superior fuel for gasoline vehicles, but it also has a number of properties that are have disadvantages for existing car fleets. The high octane rating and oxygen content can provide high energy efficiencyand cleaner exhaust emissions compared to regular gasoline. The more ethanol added to the gasoline, the better the effects. Ethanol fuels can cause starting problems, but technical solutions are available. Especially in smaller amounts, ethanol in gasoline contributes to increased evaporative emissions from the fuel system compared to regular gasoline usage. It is more corrosive than gasoline.

While the fossil fuel dependency is reduced due to application of ethanol in vehicles, mitigation of GHG emissions is in some cases doubtful. Ethanol's potential for GHG mitigation ethanol depends heavily on the production method, including the choice of crop for feedstock. There is still a significant input of fossil-based energy related to ethanol production. N2O emissions strongly reduce the potential for GHG mitigation. Carbon sequestration is a serious issue as well when land is cleared for feedstock production. Concerns have been raised about the sustainability of ethanol production. There is the potential for conflicts with other biomass-consuming sectors, most importantly, food production. Important issues such as the potential for GHG mitigation are not accounted for. There are land use issues such as water usage and pollution, destruction of valuable natural habitats, and more. Second-generation ethanol seems to be a solution to many of these issues. Ethanol can be an important contributor to the reduction of anthropogenic GHG emissions. With the use of integrated production methods, as for example fuel, fodder, and power coproduction, significant *symbiotic* benefits can be achieved. Carbon capture and storage methods can be applied in the production of ethanol and could ultimately reduce atmospheric CO2 content.

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