

ETHANOL

Ethanol is a clear, colorless liquid alcohol, which is also called ethyl alcohol, grain alcohol, or ETOH. Ethanol is a renewable source of energy made by fermenting any biomass high in carbohydrates (starch, sugar, and cellulose) through a process similar to brewing beer. It is most commonly produced from field corn, sugar cane, or wheat, but is also being made from other grains, cheese whey, and waste from the beverage, brewery, and wine industries. New technologies may soon enable the production of ethanol from cellulose from rice straw, forest residue, sawdust, pulp and paper sludge, and dedicated energy crops such as switchgrass, prairie grass, and fast-growing poplar trees.

HISTORY

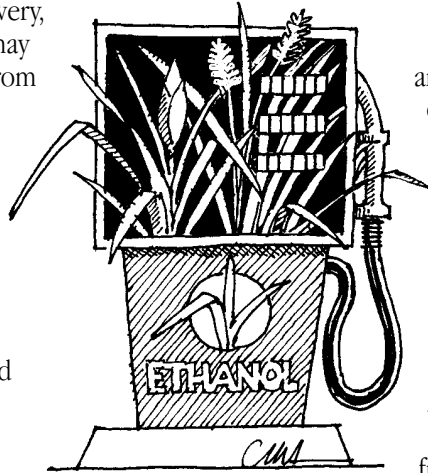
Ethanol has been used as a transportation fuel since Henry Ford and other transportation pioneers began developing automobiles. In the 1880s, Ford used ethanol to fuel one of his first automobiles, the quadricycle. In 1908, the Ford Model T was designed with a carburetor adjustment that could allow the vehicle to run on ethanol fuel produced by American farmers. Ford's vision was to "build a vehicle affordable to the working family and powered by a fuel that would boost the rural farm economy."

During the 1930s, more than 2,000 service stations in the Midwest sold ethanol made from corn, but the ethanol industry closed down in the '40s with the coming of low-priced petroleum. During World War I and II in both the United States and in Europe, alcohol fuels supplemented supplies of oil-based fuels. During World War II, the government even commandeered whiskey distilleries for alcohol fuel production. In recent history, public interest in alcohol as a transportation fuel has changed with periods of war and the fluctuating supply and price of oil. The oil crisis in the 1970s raised the price of oil and gas and gave birth to the gasohol era, when gasoline was extended with the addition of 10 percent ethanol. (Gasohol is not considered an alternative fuel.) When gasoline became more plentiful, ethanol was blended with gasoline to increase the octane rating, and the name gasohol was replaced with names reflecting the increased octane. Unleaded plus or super unleaded are two examples of names used today.

CURRENT USES

Ethanol-powered vehicles have been used in countries that produce crops suitable for ethanol

production; for example, in Brazil more than four million ethanol vehicles run on ethanol produced from sugar cane. In the United States, vehicles using mixtures of ethanol and gasoline can be found in the Midwest, where much of the corn used to make ethanol is grown and processed into fuel. Ethanol fueling sites were first established in Illinois, Iowa, South Dakota, Minnesota, and Colorado.



Ethanol is most commonly used in cars and light trucks in a blend of 85 percent ethanol and 15 percent gasoline called E85. E95, a blend of 95 percent ethanol and 5 percent gasoline, is used in heavy vehicles. Ethanol is also a component of reformulated gasoline and is used in some regions of the country to reduce carbon monoxide emissions.

SOURCE, PRICING, AND AVAILABILITY

In the United States, most ethanol is made from corn. In the 1990s, all of the ethanol used for vehicle fuel originated within U.S. borders. The price of ethanol is influenced by seasonal changes in the availability and price of feedstocks used to make it. For example, flooding of the Mississippi River in 1993 resulted in a smaller corn crop, which briefly raised the price of corn and the regional price of ethanol fuel. Prices are also affected by competing demands for ethanol, such as its use in reformulated gasoline or gasohol.

STORAGE AND SAFETY

Because ethanol is toxic if ingested, it is denatured to prevent consumption. It may also contain additives that could be harmful if inhaled or consumed. Although ethanol is harmful to organisms, it rapidly biodegrades in surface water, groundwater, and soil, thus rendering it harmless. Because ethanol can be corrosive to some metals and damaging to rubbers (gaskets and seals), fuel-storage tanks and dispensing equipment must be corrosion and damage resistant. Ethanol has a low vapor pressure and a broad range of flammability. Ethanol burns in air with a visible blue flame.

PERFORMANCE

Power, acceleration, payload, and cruise speed are comparable with those of other fuels. Ethanol is a high-octane fuel. When added to gasoline, it boosts the octane levels to help the car run more smoothly.

RANGE AND REFUELING

If the compression ratio is optimized for a higher octane rating, ethanol has approximately 80 percent or more of the energy density of gasoline. The lower energy content yields a slightly lower driving range per gallon (75 to 90 percent); therefore, an ethanol-powered vehicle requires more frequent fueling. As with gasoline or diesel fuel, ethanol is dispensed from pumps.

MAINTENANCE AND VEHICLE ALTERATIONS

Maintenance of ethanol-powered vehicles is similar if not identical to that of gasoline-powered vehicles; some of the parts and lubricants must be specially designed, however. For example, because ethanol is corrosive, noncorroding hoses must be used, and stainless-steel fuel tanks are required. The compression and timing features must be modified. Ethanol doesn't leave waxy deposits, as does gasoline, so the fuel system remains cleaner.

Diesel engines cannot simply be converted to ethanol operation. Ethanol has a very low cetane number, which describes the ability of a fuel to be ignited in compression-ignition diesel engines. One conversion approach is using the direct injection of ethanol, which will, after other slight adjustments to the engine, allow proper ignition of ethanol.

EMISSIONS

In December 1997, the U.S. Department of Energy conducted a fuel-cycle study that included the energy required to grow and harvest the corn, distill it into ethanol, and transport the ethanol to gasoline terminals. Plants grown for ethanol production absorb carbon dioxide during growth, which partially offsets the carbon dioxide emitted during fuel combustion. Studies concluded that compared with conventional gasoline, ethanol produced from corn reduces fossil energy use by 50 to 60 percent and greenhouse-gas emissions by 35 to 46 percent. Ethanol produced from cellulose materials can reduce greenhouse gas emissions even more.

Ethanol contains no sulfur, an element that reduces the effectiveness of emissions control devices. Without sulfur, emissions control devices work better, thereby reducing emissions of other pollutants.

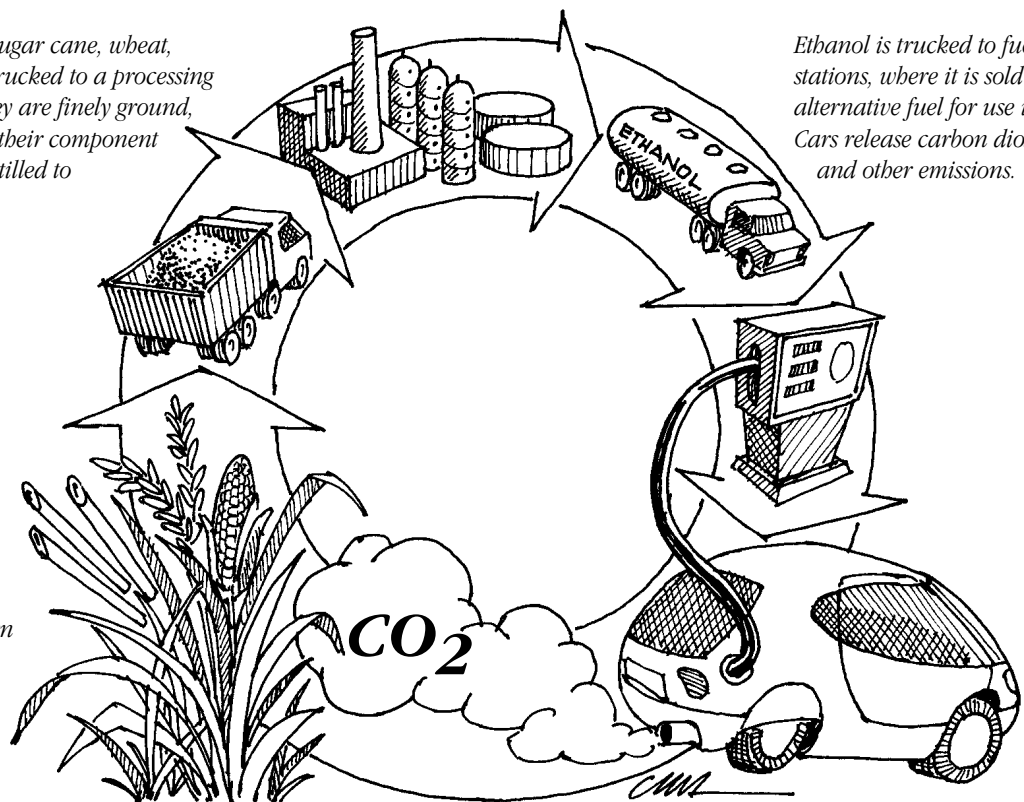
Ethanol contains 35 percent oxygen by weight. When added to gasoline, ethanol (and other oxygenates) enhances combustion, resulting in a more efficient burn. This greatly reduces exhaust emissions, including hydrocarbons, NO_x and CO (precursors to ozone), fine particulates, and toxics.

ETHANOL IN THE CARBON CYCLE

Crops such as sugar cane, wheat, and corn are trucked to a processing plant where they are finely ground, separated into their component sugars, and distilled to make ethanol.

Ethanol is trucked to fueling stations, where it is sold as an alternative fuel for use in cars. Cars release carbon dioxide and other emissions.

Sugar cane, wheat, and corn



Growing more of the original crops absorbs the carbon dioxide. The other emissions are less than those of a gasoline-powered car.