

Ethanol as a Transportation Fuel



What is ethanol?

Ethanol, or ethyl alcohol, has the chemical formula C_2H_5OH . While most familiar as the form of alcohol found in alcoholic beverages, ethanol also makes an effective motor fuel, with decades of motor fuel application experience in the U.S. and other countries.

How is ethanol being used as transportation fuel?

Most ethanol used for fuel is being blended into gasoline at concentrations of 5 to 10 percent. Ethanol has replaced methyl tertiary butyl ether (MTBE) as a gasoline component in California, and over 95 percent of the gasoline supplied in the state today contains 6 percent ethanol. There is a small but growing market for E85 fuel (85 percent ethanol and 15 percent gasoline) for use in flexible fuel vehicles (FFVs), several million of which have been produced by U.S. automakers. Ethanol is also being used to formulate a blend with diesel fuel, known as "E-Diesel", and as a replacement for leaded aviation gasoline in small aircraft.

What are ethanol's characteristics as a motor fuel?

Ethanol's lower volumetric energy content means that about one-third more ethanol is required to travel the same distance as on gasoline. But other ethanol fuel characteristics, including a high octane rating, result in increased engine efficiency and performance. The 15 percent gasoline used to formulate E85 is to assure cold weather engine starting and to enhance flame luminosity in case of fire. In low-percentage blends with gasoline, ethanol results in increased vapor pressure, which can be adjusted for in the fuel formulation process and/or controlled with on-board vehicle systems. All gasoline vehicles in use in the U.S.

today can accept gasoline blended with up to 10 percent ethanol. FFVs are built with special fuel system components designed to be compatible with high ethanol concentrations and operate properly on any E85/gasoline mixture.

How and where is ethanol produced?

Today's expanding U.S. fuel ethanol industry uses mostly corn, which is processed via fermentation and distillation to produce ethanol, animal feed, and other

byproducts. Midwestern states, including Iowa, Illinois, Minnesota, and Nebraska, are the largest



*Corn harvesting
Photo courtesy of Warren Gretz of the
National Renewable Energy Laboratory*

ethanol-producing states; however, there is some ethanol production in twenty states. California currently has two small ethanol producers, Parallel Products in Rancho Cucamonga, and Golden Cheese in Corona, both of which make ethanol from food and beverage industry residuals, and several new larger projects underway to produce ethanol from corn. Brazil is the world's top ethanol producer, using sugar cane as the feedstock.

What new ethanol sources are being pursued?

More U.S. states and foreign countries are becoming ethanol producers, employing traditional crop feedstocks and processes. In addition, new technologies for producing ethanol from agricultural,

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forestry, and municipal wastes and residues are the focus of major research and development efforts in the U.S. and other countries. Future ethanol production projects are being planned in California using agricultural crops such as sugar cane, and eventually, various waste and residual feedstocks when technologies for processing these materials become commercially available.

What are the economics of ethanol compared to gasoline?

The cost of producing ethanol remains significantly higher than the cost of producing fuels from petroleum. The U.S. Government, since 1978, has applied tax incentives intended to make ethanol competitive with gasoline in the motor fuel marketplace. Continued progress with both conventional and advanced ethanol production technologies could someday result in ethanol production costs competitive with petroleum fuels.

What are ethanol's environmental characteristics?

Produced renewably from agricultural crops or from recycled wastes and residues, ethanol used as motor fuel offers a way to reduce greenhouse gas emissions from transportation sources. With respect to other motor vehicle emissions, differences between ethanol and gasoline are becoming less significant as new motor vehicles are produced with extremely low emission levels on all fuels. California's

replacement of MTBE with ethanol was based on a determination that ethanol presents less of a water pollution risk.

How is ethanol fuel transported, stored and distributed?

Most of California's current ethanol fuel supply is delivered from the producing states via standard rail tank cars, with some

import shipments via marine vessels. It is then stored at fuel terminals and added to gasoline when tank trucks are filled for delivery to fueling stations, where it is stored and dispensed the same as non-ethanol gasoline. E85 dispensers require use of upgraded



*Ethanol Dispenser
Photo courtesy of the
Regional Transportation Center,
San Diego, CA*

materials compatible with ethanol's chemical properties. Also, due to certain ethanol properties, fuel transport pipelines in the U.S. do not currently ship ethanol or gasoline containing ethanol, although experience in Brazil and elsewhere indicates that pipeline shipment can be feasible. To prevent diversion for human consumption, federal regulations require ethanol produced for fuel use to have a denaturant (usually gasoline) added before shipping.



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