

freedomCAR & vehicle technologies program

U.S. Department of Energy • Office of Energy Efficiency and Renewable Energy

Just the Basics

Ethanol

Alcohol and driving don't mix. Or do they? Actually, they go together just fine, so long as your vehicle is the one consuming the alcohol. Ethanol, which is 200-proof alcohol, the kind found in whiskey, wine, and beer, is an excellent fuel after it is denatured to make it unfit for human consumption.

Why Is Ethanol Important?

Ethanol offers many advantages over gasoline and diesel fuel. For one thing, it's derived from plant matter, which is a sustainable resource, so supplies can be replenished indefinitely. For another, ethanol is produced domestically, making inventories immune to shortages created by foreign powers, as happened in the 1970s and again around 1990 with crude oil. Also, using ethanol in place of gasoline or diesel fuel helps boost the U.S. economy.

On top of all that, vehicles running on ethanol produce significantly fewer harmful emissions than vehicles burning gasoline. Unlike petroleum-based fuels, ethanol produces no net carbon dioxide emissions. That's because ethanol is made from plants that remove carbon dioxide from the air while growing. In fact, more carbon dioxide is removed during crop growth than is released to the air during the manufacture and use of ethanol as a fuel, so using ethanol actually lessens the amount of carbon dioxide in the atmosphere on an

overall basis. Carbon dioxide is a greenhouse gas that contributes to global warming by preventing some of the sun's radiation from escaping the Earth.

How Ethanol Works

Ethanol helps keep engines clean, too. It burns more completely and at a slightly cooler temperature than gasoline. This means longer spark plug life and fewer combustion deposits. Ethanol burns well because it is an oxygenate, meaning that ethanol molecules contain oxygen. Oxygen atoms inside ethanol join forces with oxygen molecules in the air to help ethanol burn more completely. This extra amount of oxygen also helps gasoline burn better when it is blended with ethanol. Better combustion is an important factor leading to fewer harmful emissions. A blend containing 10% ethanol and 90% gasoline (called E10) can reduce carbon monoxide emissions from older vehicles by as much as 25%.

Emissions of smog-producing hydrocarbons, soot particles, and toxic and ozone-producing chemicals are reduced, as well. You may be aware of E10 without realizing it. The Clean Air Act Amendments of 1990 specify that a certain amount of oxygen be added to gasoline, in the form of an



Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle

How is ethanol made?

As an alcohol, ethanol is made using a process similar to that used in making beer.



Ethanol can be made using the cellulose from trees, grasses, agricultural residues, waste paper, waste wood, and other biomass.



These "feedstocks" are converted into sugar.



The sugar is fermented into ethanol and then distilled into its final form.

vehicle systems

oxygenate like ethanol, when it is intended for sale in congested urban areas where cars and trucks emit carbon monoxide in unhealthy amounts. The purpose of the regulation is to reduce production of this pollutant through better fuel combustion, particularly in the wintertime when carbon monoxide levels tend to skyrocket. To learn whether you live in one of these regions of the United States, look for signs on gas pumps that say the gasoline being dispensed is 10% ethanol.

Pure ethanol has fewer highly volatile components than gasoline, making it less likely to ignite at low temperatures. That means vehicles using pure ethanol tend to be harder to start when their engines are cold, especially in the wintertime. Gasoline mixed with ethanol prevents this problem with E10 and other ethanol blends. Besides E10, ethanol is sold as E85 (85% ethanol and 15% gasoline) for light-duty vehicles and as E95 (95% ethanol and 5% gasoline) for heavy-duty vehicles, such as buses and trucks.

What Are Flexible-fuel Vehicles?

Although all major foreign and domestic auto manufacturers approve the use of E10 in their standard gasoline-fueled vehicles, the same cannot be said of E85. Ethanol's high octane rating necessitates running an engine at a higher compression ratio than would be appropriate for a standard gasoline vehicle.

Another concern is corrosiveness. Alcohols are generally more corrosive than gasoline. Vehicles designed for E85 meet these challenges with special lubricants and selected components made from advanced materials. All major U.S. automakers offer cars, vans, and light trucks designed for E85, often at the same prices as their gaso-

line counterparts. These are flexible-fuel vehicles that can run on E85, gasoline, or any combination of the two. About one million light-duty E85 vehicles were in service in 2000, mostly in corporate or government fleets. Adopting flexible-fuel vehicles helps fleet owners comply with the Energy Policy Act of 1992.

Although E95 is a good fuel for buses and trucks, it cannot be used in standard diesel engines. So tests are under way to determine whether a new ethanol-based fuel can power such heavy-duty vehicles without extensive engine modifications. Called oxygenated diesel or E-diesel (E stands for ethanol), the new fuel contains 15% ethanol, 80% diesel fuel, and 5% of an additive that helps the components stay mixed together. This blend promises to significantly reduce exhaust emissions from heavy-duty vehicles while helping to lessen U.S. dependence on foreign oil.

The Future of Ethanol

Ethanol producers in the United States generate around 1.5 billion gallons of ethanol each year, most of which is derived from corn. As demand for ethanol increases, other domestic biomass resources, such as agricultural and forestry wastes, municipal solid wastes, industrial wastes, and crops grown solely for energy purposes, will be used to make ethanol.

Use of such materials will help reduce our country's trade deficit and creates jobs. Our agricultural community especially stands to benefit, since making ethanol and other fuels from crops and agricultural residues will provide for new valuable crops and new uses for existing crops and residues.

In a few years, it is expected that the automotive industry will start producing vehicles that are propelled by fuel cells instead of internal

combustion engines. These revolutionary vehicles need to burn hydrogen, which will be produced from other fuels by an onboard device called a fuel reformer. Research sponsored by the U.S. Department of Energy has recently led to the development of the first reformer that can create hydrogen from several different fuels, including ethanol. Developers of this cutting-edge technology say that ethanol produces higher engine efficiencies, fewer emissions, and offers better engine performance than other fuels, even gasoline.

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



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