

ETHANOL 101

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What is ethanol?

Gasoline is not the only fuel that can power cars! Cars can actually be powered by corn, sugar cane, wheat, potatoes, cellulosic materials and other feedstocks (unprocessed natural products used in manufacturing) that are converted into ethanol. Ethanol is a clear, grain alcohol produced from renewable sources that can be used as fuel. Ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) is an organic compound that is considered an alcohol since it has a hydroxyl group (OH) attached to a carbon atom.

Pure ethanol is generally mixed with a percentage of gasoline when used as motor fuel. There are two common types of ethanol that are used in vehicles – E10 and E85. E10 is a blend of 10% ethanol and 90% gasoline. All cars are capable of using E10 as fuel. E85, on the other hand, is 85% ethanol and 15% gasoline. E85 is considered an “alternative fuel” for use in Flexible Fuel Vehicles (FFVs). These vehicles can either run on E85 or regular gasoline.

Ethanol is not a new fuel source. Henry Ford’s Model T was designed to run on ethanol.

How is ethanol made?

In simple terms, ethanol is made by fermenting starch or sugar from feedstock, and then distilling it into alcohol. Most of the ethanol produced in the U.S. is distilled from corn. In Brazil, sugar cane is used to make ethanol. Ethanol can also be made from cellulosic biomass. Cellulosic materials include corn stalks and husks, wheat and barley straw, rice or sugar cane bagasse (fibre from crushing the sugar cane), willow and poplar trees, switchgrass, and municipal waste. Cellulosic ethanol is made the same way; however, the sugars in cellulose are more complex than those found in corn, and need to be separated carefully for the process to work and require more effort to break down. The ethanol produced by cellulose is the same as that made from corn.

How much corn does it take to make ethanol?

According to the Department of Energy, it takes one bushel of corn to make 2.5 gallons of ethanol. (Some sources indicate that the yield can be as high as 2.8 gallons.) Since only part of the corn kernel is used to make the ethanol, one bushel of corn also yields:

- 1.6 lbs of corn oil
- 2.6 lb of corn meal
- 10 lbs of high protein feed
- 31.5 lbs of starch used for beverages and sweeteners

According to the American Coalition for Ethanol, 2.81 billion gallons of ethanol were produced in 2003. Over the past few years, ethanol production has increased:

- 2004 – 12% of the nation’s corn crop was used to produce 3.4 billion gallons of ethanol
- 2005 – 14% of the nation’s corn crop was used to produce 4 billion gallons of ethanol
- 2006 – an estimated 20% of the nation’s corn crop will be used to produce about 5 billion gallons of ethanol

Approximately 50 million gallons of ethanol are used to make E85.

Does ethanol have a positive net energy balance?

A fuel source has a positive net energy balance if it produces more energy than is required to make it. The energy needed to create ethanol from corn includes the energy required to grow the corn, and the energy required to convert the corn into alcohol, which most likely involves the use of fossil fuels such as coal or oil.

According to the Department of Energy, ethanol has a positive net energy balance, that means that it provides about 25% more energy than is used to make it, including growing the corn, harvesting it, and distilling it into alcohol. It takes about 0.74 million Btu (Btu is an abbreviation for British thermal unit, a standard unit of energy.) of “Fossil Energy Input” to yield 1 million Btu of ethanol.

Why use ethanol as a fuel?

There are many environmental and economic benefits to using ethanol as a fuel source. Ethanol-blended fuel has a high oxygen content, which enables it to burn more completely and create less pollution. It reduces the carbon monoxide and hydrocarbon emissions that come from a vehicle’s tailpipe. Likewise, according to the Department of Energy’s Argonne National Laboratory, ethanol-blended fuels reduced the CO_2 equivalent greenhouse gas emissions by 7.8 million tons in 2005. That’s like removing the greenhouse gas emissions of over one million cars from the road.



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Increasing the use of ethanol-blended fuels produced in the U.S. helps to reduce the country's dependence on oil and foreign suppliers. The American Coalition for Ethanol reports that one barrel of ethanol (42 gallons) can displace 1.2 barrels of petroleum at the refinery. While the 4 billion gallons of ethanol produced in 2005 equals only about 3% of the total U.S. gas consumption for a year (about 140 billion gallons) there's potential for ethanol. The government has suggested a proposal to help reduce present gasoline consumption by blending it with ethanol and other alternative fuels. The plan seeks for a 20% reduction in gasoline usage by 2017. Improvements in production, technology, and awareness may yield higher results in the future.

Is there a downside to ethanol?

The production and use of renewable ethanol-blended fuels is increasing. However, the number of production facilities and supplies or availability of E85 are currently limited. In addition, while ethanol is cost-efficient to produce, there is a drawback to E85 – there is approximately a 10% decrease in energy per mile for E85 relative to gasoline, meaning that a car does not get as many miles from a gallon of E85 as it does from a gallon of gasoline.

Think About It!

Answer the following questions based on the information about ethanol.

1. What is the difference between E10 and E85? _____

2. In the U.S., what is the primary source for ethanol production? _____
In Brazil? _____
3. If it takes one bushel of corn to make 2.5 gallons of ethanol, how many bushels did it take to make the ethanol produced in the U.S. in 2005? _____
How many pounds of corn meal could be created from this many bushels? _____
4. What does it mean that ethanol "has a positive net energy balance?" _____

5. Is ethanol energy efficient to produce? Why or why not? _____

6. What do you consider to be the pros and cons of using ethanol as a fuel? List your answers below.

Pros

Cons

Sources and References

American Coalition for Ethanol: www.ethanol.org
 Department of Energy - Energy Efficiency and Renewable Energy: www.eere.energy.gov
 Department of Energy Kid's Page: www.eia.doe.gov/kids
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