We're Going Global

ETHANOL

What is Ethanol?

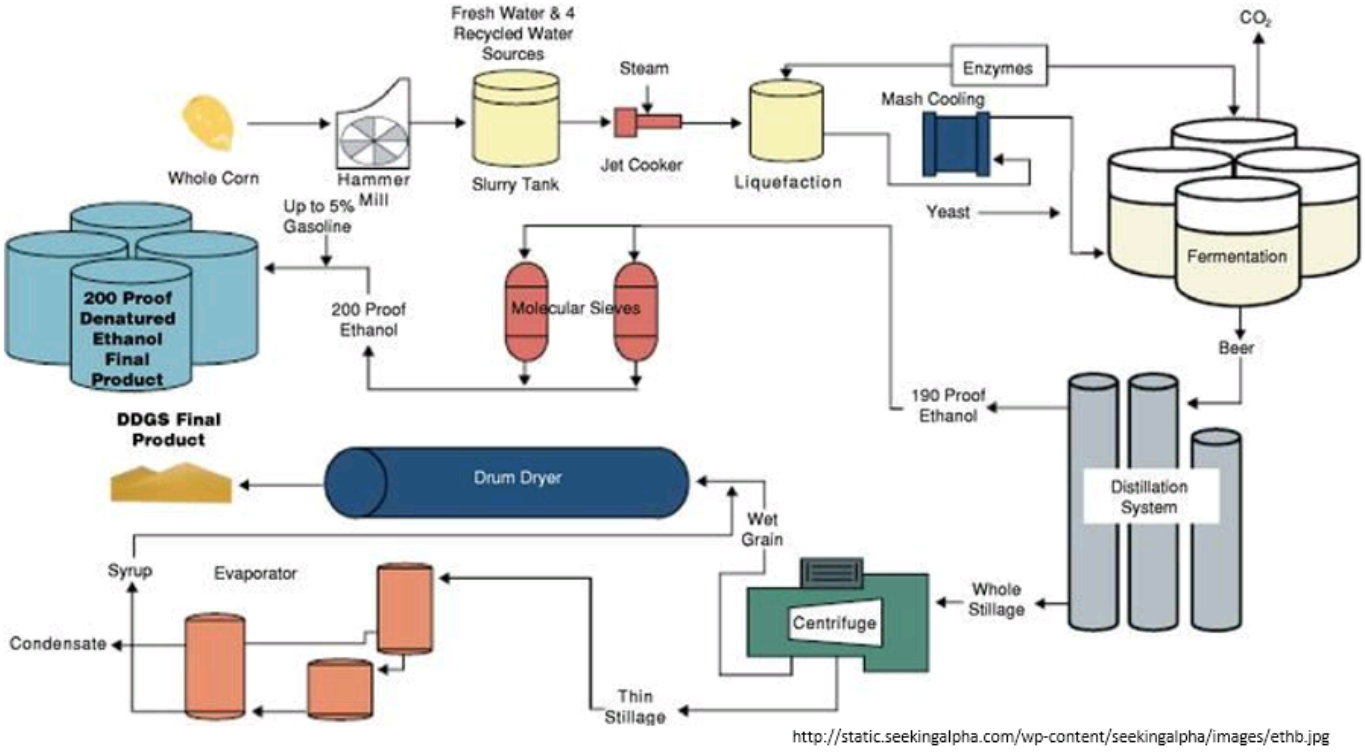
Ethanol is clean-burning, high-octane alcohol-based fuel made by fermenting and distilling starch crops, such as corn or sugar cane. It can also be made from "cellulosic biomass" such as wood, grasses or the inedible parts of plants. The use of ethanol can reduce dependence upon oil and reduce greenhouse gas emissions.

Today, over 95% of all fuel sold in the U.S. is blended with 10% ethanol. This 10% ethanol blend in gasoline consumed roughly 40% of the national corn crop.

How Ethanol is Produced

A bushel of corn weighs approximately 56 pounds and will produce 2.8 gallons of ethanol, 17 pounds of distiller's grain and 18 pounds of carbon dioxide.

Ethanol production utilizes only the starch in the grain. The distiller's grain (protein, fat and fiber) are then used as animal feed. The evolved carbon dioxide is used to carbonate beverages, to manufacture dry ice and to flash freeze meat. CO2 is also used by paper mills and other food processors.



http://static.seekingalpha.com/wp-content/seekingalpha/images/ethb.jpg

Ethanol Production Process from Corn

1. Milling: the corn passes through a mill and is ground it into a fine powder called meal.
2. Liquefaction: The meal is mixed with water and the enzyme alpha-amylase. It is cooked and the starch is liquefied.
3. Saccharification: the 'mash' from the cookers is cooled and the secondary enzyme gluco-amylase is added to convert the liquefied starch to a fermentable sugar called dextrose.
4. Fermentation: yeast is added to the mash to ferment the sugars to ethanol and carbon dioxide.
5. Distillation: the fermented mash contains about 10% alcohol plus all the non-fermentable solids from the corn and yeast cells. The mash is pumped to a distillation system where the alcohol is evaporated and condensed from the solids and the water. The alcohol leaves the top of the final column at about 96% strength.
6. Dehydration: the alcohol from the top of the column passes through a dehydration system where water is removed. The alcohol product at this stage is called anhydrous ethanol and is approximately 200 proof.

Benefits of Using Ethanol in Gasoline

High Octane Blending Value

Ethanol is the cleanest and most affordable source of octane on the market today, displacing toxic aromatics such as benzene and toluene.

Ethanol - Octane Blending Value	RON	MON	R+M/2
With Premium	113.6	91.7	102.7
With Regular	137.0	102.5	119.8

Good for the Environment

Ethanol is considered to be better for the environment than gasoline. Ethanol-fueled vehicles produce lower carbon monoxide and carbon dioxide emissions. Emissions of volatile organic compounds are also reduced when ethanol is blended with gasoline.

Ethanol reduces greenhouse gas emissions by 40-50% when compared directly to gasoline. The 14.3 billion gallons of ethanol produced in 2014, reduced GHG emissions by 39.6 million metric tons-equivalent to removing 8.4 million cars from the road.

Ethanol's energy balance is continually improving: 1 unit of energy invested in making ethanol yields up to 2.3 units of energy available for the consumer.

Good for the U.S. Economy

Ethanol production supports farmers and creates domestic jobs. It is produced domestically, from domestically grown crops and reduces U.S. dependence on foreign oil.

The production of 14.3 billion gallons of ethanol in 2014 meant that the U.S. needed to import 515 million fewer barrels of petroleum products.

Producing 20 barrels of ethanol requires just 1 barrel of crude oil.

Ethanol is part of the United States' solution to reducing dependency on fossil fuels, lowering fuel prices, creating domestic jobs, boosting the farm economy, and cleaning the environment.

Renewable Fuel Standard

The Renewable Fuel Standard (RFS) Congress adopted the RFS in 2005 and expanded it in 2007. The program requires oil companies to blend increasing volumes of renewable fuels with gasoline and diesel, culminating with 36,000,000,000 gallons in 2022. The RFS has been a success. It has reduced dependence on imported petroleum, stimulated investment in new technologies, lowered gasoline prices, created jobs and economic opportunity across rural America, and reduced greenhouse gas emissions from transportation fuels.

Problems with Using Ethanol in Gasoline

Mileage

Vehicles will typically go 3–4% fewer miles per gallon on E10 than on straight gasoline.

Volatility (RVP)

The addition of 10% ethanol to a summer grade gasoline increases the Vapor Pressure (RVP) of the final blended product by about 1 psi.

Volatility (Distillation T50)

Adding 10% ethanol results in a 20 to 40 deg F reduction in 50% evaporated distillation temperature (T50). There is a risk of not meeting the T50 evap minimum in ASTM D4814. Ethanol may also cause driveability issues if the T50 is too low.

Note: Neat is 100% Gasoline prior to blending in Ethanol

Grade	RBOB			Conv Reg		
	Neat	+10%EtOH	Δ	Neat	+10%EtOH	Δ
IBP D86	84.2	88.4	4.2	85.8	89.2	3.4
5% D86 Evap F	104.0	101.7	-2.3	100.5	105.0	4.5
10% D86 Evap F	115.1	112.7	-2.4	113.9	115.5	1.6
20% D86 Evap F	132.7	126.6	-6.1	136.0	130.1	-5.9
30% D86 Evap F	150.8	137.1	-13.7	159.4	142.5	-16.9
40% D86 Evap F	171.2	146.3	-24.9	183.9	151.1	-32.8
50% D86 Evap F	**195.0**	**153.6**	**-41.4**	**208.2**	**171.5**	**-36.7**
60% D86 Evap F	221.6	208.5	-13.1	232.3	225.3	-7.0
70% D86 Evap F	248.9	241.4	-7.5	258.4	251.0	-7.4
80% D86 Evap F	285.8	279.0	-6.8	296.2	289.0	-7.2
90% D86 Evap F	340.7	337.0	-3.7	345.9	342.8	-3.1
95% D86 Evap F	375.7	372.0	-3.7	381.2	376.1	-5.1
FBP D86	415.0	413.0	-2.0	413.2	412.8	-0.4

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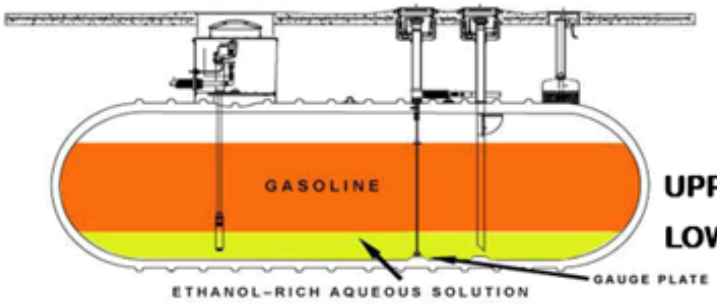
Phase Separation

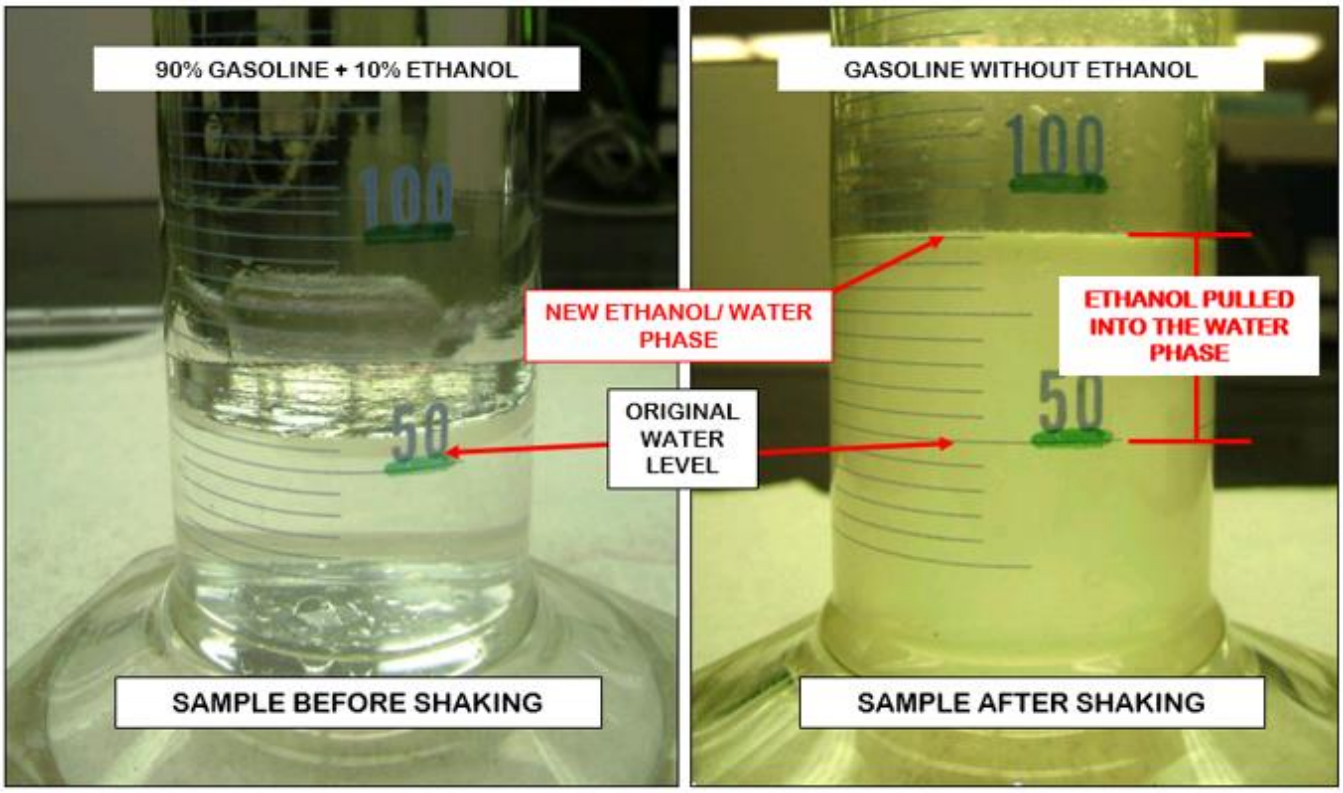
Most fuel distribution systems experience some form of water intrusion over time due to condensation in storage tanks, picking up water in transport on ships and barges, underground station storage tanks, etc. Ethanol is usually blended at the terminal truck rack in order to minimize opportunities for water contact. Phase separation can be a significant issue at customer and retail locations. In a gasoline station tank contacting the 90% gasoline / 10% ethanol blend with water will draw ethanol from the blend and into the water phase. This results an upper layer of ethanol deficient gasoline and a lower layer of ethanol rich water. It occurs because ethanol is completely soluble in water and only marginally soluble in hydrocarbons. After phase separation, the gasoline layer will have a lower octane number (the original RBOB/CBOB octane rating) and may knock in an engine. The engine will not run on the water layer.

-ETHANOL IS COMPLETELY SOLUBLE IN WATER AND ONLY MARGINALLY SOLUBLE IN GASOLINE.
-THE GASOLINE-ETHANOL BLEND CAN DISSOLVE 5,000 PPM OF WATER AT 60°F.
-CONTACTING WITH WATER WILL DRAW ETHANOL FROM THE BLEND AND INTO THE WATER PHASE.



UPPER PHASE = LOW ETHANOL AND OCTANE

LOWER PHASE = ETHANOL RICH WATER



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ASTM Specifications

D4806 Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel
(Straight Denatured Ethanol)
This specification covers nominally anhydrous denatured fuel ethanol intended for blending with unleaded or leaded gasolines for use as a spark-ignition automotive engine fuel. The only denaturants used for fuel ethanol shall be natural gasoline, gasoline components, or unleaded gasoline at the minimum concentration prescribed.

D5798 Standard Specification for Ethanol Fuel Blends for Flexible-Fuel Automotive Spark-Ignition Engines
(75-85% Ethanol Blend)
This specification covers a fuel blend, nominally 75 to 85 volume % denatured fuel ethanol (Ed75-Ed85) and 25 to 15 additional volume % hydrocarbons for use in ground vehicles with automotive spark-ignition engines.

D4814 Standard Specification for Automotive Spark-Ignition Engine Fuel
(10% Ethanol Blend)
This specification describes the various characteristics and requirements of automotive fuels in ground vehicles equipped with spark-ignition engines. The spark-ignition engine fuels covered in this specification are gasoline and its blends with oxygenates, such as alcohols and ethers.

Chemical Formula

Chemical Name: Ethyl alcohol (Ethanol)

CAS Number 64-17-5

Its structural formula CH_3CH_2OH, is often abbreviated as C_2H_5OH, C_2H_6O or EtOH.