EVERYTHING ABOUT ETHANOL©



by www.agua-luna.com

STOP GLOBAL WARMING
USE ALTERNATIVE ENERGY

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PREFACE

What is alternative energy anyway?

Alternative Energy or Alternative Fuels, are any materials or substances that can be used as a fuel, other than conventional fuels. Conventional fuels include: fossil fuels (petroleum (oil), coal, propane, & natural gas). Some well known alternative fuels include biodiesel, ethanol, butanol, chemically stored electricity (batteries & fuel cells), hydrogen, methane, natural gas, vegetable oil, biomass, & peanut oil.

In the year 2000, there were about eight million vehicles around the world that ran on alternative fuels, indicating an increasing popularity of alternative fuels. There is growing social interest, & a perceived economic & political need for the development of alternative fuel sources.

Since burning fossil fuels are known to increase greenhouse gas concentrations in the atmosphere, they are a likely contributor to global warming. Another concern is the peak oil theory, which predicts a rising cost caused by severe shortages during an era of growing energy consumption. According to the 'peak oil' theory, the demand for oil will exceed supply & this gap will continue to grow, which could cause a growing energy crisis starting by 2010. Lastly, the majority of the known petroleum reserves are located in the middle east. There is a concern that worldwide fuel shortages could intensify the unrest that exists in the region, leading to further conflict & war.





Biofuel

Plants use photosynthesis to grow & produce biomass, or biomatter, biomass can be used directly as fuel. Agriculturally produced biomass fuels, such as biodiesel, ethanol & bagasse (often a by-product of sugar cane) can be burned in internal combustion engines or boilers.

Biodiesel can be used in modern diesel vehicles with little or no modification to the engine & can be made from waste, vegetable, animal oil & fats (lipids). Vegetable oils can be used in modified diesel engines. In fact the Diesel engine was originally designed to run on vegetable oil rather than fossil fuel. A major benefit of biodiesel is lower emissions. The use of biodiesel reduces emission of carbon monoxide & other hydrocarbons by 20 to 40%.

In some areas corn, cornstalks, sugarbeets, sugar cane, & switchgrasses are grown specifically to produce ethanol (also known as grain alcohol) a liquid which can be used in internal combustion engines & fuel cells. Ethanol is being phased into the current energy infrastructure. E85 is a fuel composed of 85% ethanol & 15% gasoline that is sold to consumers.

Solid biomass

Direct use is usually in the form of combustible solids, either wood, the biogenic portion of municipal solid waste or combustible field crops. Field crops may be grown specifically for combustion or may be used for other purposes, & the processed plant waste then used for combustion. Most sorts of biomatter, including dried manure, can actually be burnt to heat water

& to drive turbines. Sugar cane residue, wheat chaff, corn cobs & other plant matter can be, & is, burnt quite successfully.

Biogas can easily be produced from current waste, such as: paper, sugar production, sewage, animal waste & so forth. These various wastes have to be slurried together & allowed to naturally ferment, producing methane gas. When a biogas plant has extracted all the methane it can, the remains are sometimes better suitable as fertilizer than the original biomass.

Other Fuels



Methanol (methanol economy) from any source can be used in internal combustion engines with minor modifications. It usually is made from natural gas, sometimes from coal, & could be made from any carbon source including CO2. Flexible fuel vehicles may run with a high percentage of ethanol (ethanol economy) (up to 85% Ethanol plus 15% gasoline for cold-starting vapor pressure) with no modifications.
Hydrogen

Interest in vehicles powered by alternative energy sources has been gaining traction in large part due to high gas prices & an increased awareness of global warming, which according to a recent Intergovernmental Panel on Climate Change (IPCC) report is 90% likely caused by humans.

Diesel type biofuels: Hempseed oil fuel or other straight vegetable oils, Biodiesel
Others with internal combustion, Ethanol, E85, Hydrogen internal-combustion, Ammonia, Natural gas, compressed or liquified, Autogas (LPG, LP gas, propane), Synfuel, synthetic fuels, Plug-in hybrid electric vehicle
External combustion, Organic waste fuel, Wood gas on-board gasification, Steam engine cars (like the Stanley Steamer)
No combustion, Electric vehicle, Solar cell-powered or -charged electric cars, Hydrogen fuel cell, MAGLEV with induction drive (a variety of electric mass transit), Air car working on compressed air
Some less conventional alternative fueled cars:, Nuclear powered, Solar Radiation, Sail

Ok, what is renewable energy then?

Renewable energy flows involve natural phenomena such as sunlight, wind, tides & geothermal heat. Each of these sources has unique characteristics which influence how & where they are used.

Wind power

Wind power is the fastest growing of the renewable energy technologies. Over the past decade, global installed maximum capacity increased from 2,500 MW in 1992 to just over 40,000 MW at the end of 2003, at an annual growth rate of near 30%. Globally, the long-term technical potential of wind energy is believed to be five times current production global energy consumption or 40 times current electricity demand. Wind power is renewable & produces no greenhouse gases during operation, such as carbon dioxide & methane.



Offshore wind turbines near Copenhagen

Water power

Energy in water (in the form of motive energy or temperature differences) can be harnessed & used. Since water is about a thousand times denser than air, even a slow flowing stream of water, or moderate sea swell, can yield considerable amounts of energy.

There are many forms of water energy:

Hydroelectric energy is a term usually reserved for large-scale hydroelectric dams.
Micro hydro systems are hydroelectric power installations that typically produce up to 100 kW of power. They are often used in water rich areas as a Remote Area Power Supply (RAPS). There are many of these installations around the world, including several delivering around 50 kW in the Solomon Islands.
Wave power uses the energy in waves. The waves will usually make large pontoons go up & down in the water, leaving an area with reduced wave height in the "shadow". Wave power has now reached commercialization.
Tidal power captures energy from the tides in a vertical direction. Tides come in, raise water levels in a basin, & tides roll out. Around low tide, the water in the basin is discharged through a turbine.
Tidal stream power captures energy from the flow of tides, usually using underwater plant resembling a small wind turbine. Tidal stream power demonstration projects exist, but large scale development requires additional capital.
Ocean thermal energy conversion (OTEC) uses the temperature difference between the warmer surface of the ocean & the colder lower recesses. To this end, it employs a cyclic heat engine. OTEC has not been field-tested on a large scale.
Deep lake water cooling, although not technically an energy generation method, can save a lot of energy in summer. It uses submerged pipes as a heat sink for climate control systems. Lake-bottom water is a year-round local constant of about 4 ℃.
Blue energy is the reverse of desalination. This form of energy is in research.

Solar energy use

A photovoltaic (PV) module that is composed of multiple PV cells. Two or more interconnected PV modules create an array.

In this context, "solar energy" refers to energy that is collected from sunlight. Solar energy can be applied in many ways, including to:

Generate electricity using photovoltaic solar cells.
Generate electricity using concentrated solar power.
Generate electricity by heating trapped air which rotates turbines in a Solar updraft tower.

Heat buildings, directly, through passive solar design.
Heat foodstuffs, through solar ovens.
Heat water or air for domestic hot water & space heating needs using solar-thermal panels.
Heat & cool air through use of solar chimneys.

Geothermal energy



Krafla Geothermal Station in Iceland

Geothermal energy is energy obtained by tapping the heat of the earth itself, usually from kilometers deep into the Earth's crust. It is expensive to build a power station but operating costs are low resulting in low energy costs for suitable sites.

Potential

While currently renewable energy sources only supply a modest fraction of current energy use (ca. 14% of primary energy use), there is much potential that could be exploited in the future.

The Renewable Energy Resource Base (Exajoules a year)

	Current use (2001)	Technical potential	Theoretical potential
Hydropower	9	50	147
Biomass energy	50	>276	2,900
Solar energy	0.1	>1,575	3,900,000
Wind energy	0.12	640	6,000
Geothermal energy	0.6	5,000	140,000,000
Ocean energy	not estimated	not estimated	7,400
Total	60	>7,600	>144,000,000

Current use is in primary energy equivalent.
For comparison, the current global primary energy use (2001) is 402 Exajoules a year.
Source: World Energy Assessment 2001.

References

U.S. Department of Energy
GTA Energy, Inc.
Small-scale Biogas Use in Costa Rica

BACKGROUND

The concept of providing for one's self isn't new. Humans have always been self-sufficient. Only in today's hectic day-to-day society do we find ourselves relying too much on others. In yester-year, a family had to kill themselves bringing the bare necessities to the home. Today the technology has changed as well as the materials, making it easier and more efficient to live comfortably independent.
Still, trying to walk YOUR path in this environment can seem impossible. Society wants us to all move as sheep, working, sleeping, eating together; drowsy drones pushing a machine for reasons we aren't aware of, yet attach to the comfort of our family. Well, how harmonious is a family without a Dad / Husband or Mother / Wife? Why? When there are other ways to *Live Life Simpler*. The Rat Race will have you believe it's not that simple. I'd have you believe it is. The truth will, in the end, be up to you. New ideas will take getting used to, changes & sacrifices need to be made creating a new world. Changing your mindset will be the biggest challenge. I will discuss Alternate concepts to simplify daily activities, methods to save energy, avoiding Main Stream utilities, making *LIFE SIMPLER* by *learning everything about ethanol* for several key reasons:

• Save the environment using vegetables instead of fossil fuels.
• Control your funds. On vacation? No monthly expenses wasted.
• Expand your knowledge, challenge yourself, acquire personal satisfaction.
• *Retire Early*, with no bills to pay.
• Don't follow the Rat Race. Live for yourself.
• Tired of sending checks? Are bill collectors hounding you?
• What type of water is the city giving you? What chemicals are you drinking? Control your own water supply.
• What viruses, bacterias and bugs are coming through city septic? What will come through it in the future?

I am a 28-year-old retired structural engineer from *Boeing Aerospace*, with an extensive background in fluid and structural dynamics. That said, I disconnected from the grid for one reason. Cost. You'll find that given a few years not only will your system pay for itself, but it could actually start paying <u>you</u>. Enjoy self-sufficiency.

THE SYSTEM

There is an endless list of ways to *Live Life Simpler*. I've only skimmed the surface in this booklet. For years, I sat observing society's monstrous motion pushing its way through existence. I sought ways, tricks, loopholes, gaps, to make my life in the rapids simpler, cheaper, longer. You'll find that by thinking outside the box, without taking any shortcuts, you can create more time for your family, add years to your life while building & saving additional funds, thereby LIVING LIFE SIMPLER.

We will discuss every aspect about ethanol for a moderate-sized family/vehicle in a typical area. This booklet utilizes several alternate energy components you will need to run your vehicle on ethanol. I will provide a brief description of each, stating function, cost range and some sources for acquiring at the lowest costs. At the end add up the prices and calculate how many years it will take to pay for itself vs. how much you would normally spend on utilities. A normal system takes appx 6 years. Cut that in half with my booklet "How-to *Retire At Age 25."*

WARNING: I do not enclose any local ordinances or laws in my booklets, please check your local codes. You may even be able to sell your power back. Contact the power company, ask if they purchase excess energy.

The following steps are cut directly from my book due out this summer. If you like what you read now and are looking for more (solar heating/cooling, fuel from water, build your own solar panels/wind generators), you may want to be added to the waiting list. Contact us for details.

ETHANOL MADE FROM CORN AND OTHER CROPS

Ethanol is a clear, colorless alcohol fuel made from the sugars found in grains, such as corn, sorghum, and wheat, as well as potato skins, rice, and yard clippings. Ethanol is a renewable fuel because it is made from plants. There are several ways to make ethanol from biomass. The most commonly used processes today use yeast to ferment the sugars and starch in corn. Corn is the main ingredient for ethanol in the United States due to its abundance and low price. Most ethanol is produced in the corn-growing states in the Midwest. The starch in the corn is fermented into sugar, which is then fermented into alcohol. Other crops such as, barley, wheat, rice, sorghum, sunflower, potatoes, sugar cane and sugar beets can also be used to produce ethanol.

Sugar cane and sugar beets are the most common ingredients for ethanol in other parts of the world. Since alcohol is created by fermenting sugar, sugar crops are the easiest ingredients to convert into alcohol. Brazil, the country with the world's largest ethanol production, makes most of its ethanol this way. Today, many cars in Brazil operate on ethanol made from sugar cane.

A new experimental process which breaks down cellulose in woody fibers, is called "cellulosic ethanol". With this process we can make ethanol from trees, grasses, and crop wastes. Trees and grasses need less energy than grains, which must be replanted every year. Scientists have developed fast-growing trees that grow to size in ten years. Many grasses can produce two harvests a year for many years. Someday, you may find yourself driving by huge farms that are not producing food or animal feed, but feedstock for ethanol. Feedstock is the raw material used to make a product.

HISTORY OF ETHANOL

Ethanol is not a new fuel. In the 1850s, ethanol was a major lighting fuel. During the Civil War, a liquor tax was placed on ethanol to raise money for the war. The tax increased the price of ethanol so much that it could no longer compete with other fuels such as kerosene in lighting devices. Ethanol production declined sharply because of this tax and production levels did not begin to recover until the tax was repealed in 1906.

In 1908, Henry Ford designed his Model T to run on a mixture of gasoline and alcohol, calling it the fuel of the future. In 1919, when Prohibition began, ethanol was banned because it was considered a liquor. It could only be sold when it was mixed with petroleum. With the end of Prohibition in 1933, ethanol was used as a fuel again. Ethanol use increased temporarily during World War II when oil and other resources were scarce. In the 1970s, interest in ethanol as a transportation fuel was revived when embargoes by major oil producing countries cut gasoline supplies. Since that time ethanol use has been encouraged by offering tax benefits for producing ethanol and for blending ethanol into gasoline. In 1988, ethanol began to be added to gasoline for the purpose of reducing carbon monoxide emissions. Learn more about the history of ethanol in a timeline.

ETHANOL AS A TRANPSORTATIO N FUEL

As a transportation fuel, ethanol can be used as a total or partial replacement for gasoline. Gasoline containing ten percent



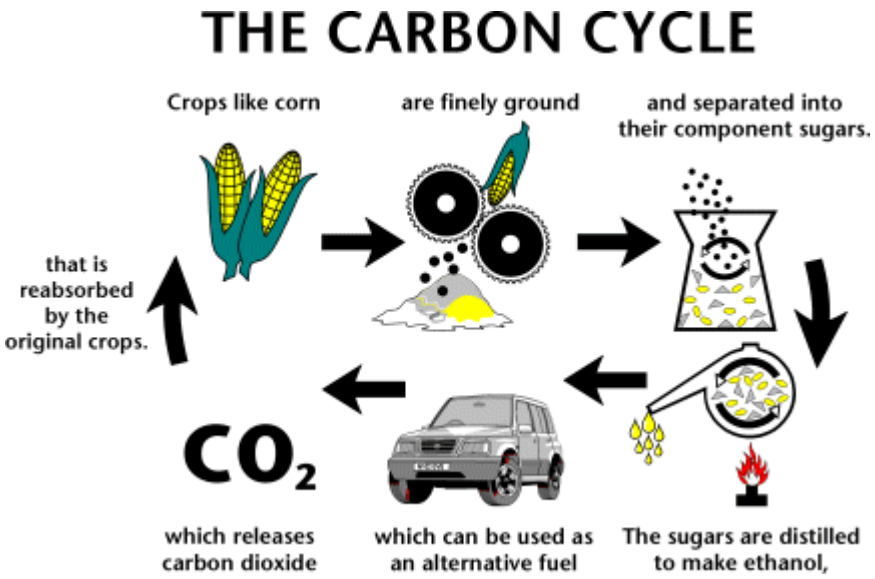
E85 pump in Lexington, KY

ethanol - E10 - is used in many urban areas that don't meet clean air standards. Some states promote more widespread use of E10. Minnesota, for example, requires almost all gasoline sold in the state to contain 10 percent ethanol. All vehicles that run on gasoline can use E10 without making changes to their engines. Over 99 percent of the ethanol produced in the United States is mixed with gasoline to make E-10.

E85 is an alternative fuel that is 85 percent ethanol and 15 percent gasoline, used mainly in the Midwest and South. Vehicles are not modified to run on E85; they are specially manufactured as flexible fuel vehicles (FFV). Flexible Fuel Vehicles can use any mixture of ethanol and gasoline up to E85. There are about 146,000 cars and trucks using E85. Most of these are fleet vehicles.

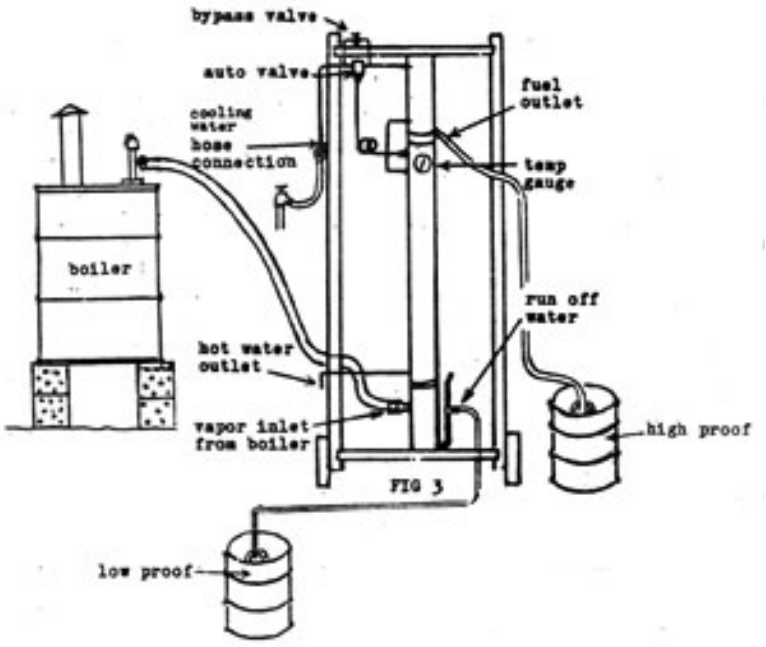
Ethanol and the Environment

Using ethanol means that we use a little bit less gasoline (a nonrenewable fuel). Unlike gasoline, ethanol is nontoxic (safe to handle) and biodegradable, it quickly breaks down into harmless substances if spilled. When small amounts of ethanol are added to gasoline, usually less than 10 percent, there are many advantages. Ethanol reduces carbon monoxide and other toxic pollution from the tailpipes of vehicles, making the air cleaner. It keeps engines running smoothly without the need for lead or other chemical additives. Because ethanol is made from crops that absorb carbon dioxide and give off oxygen, it helps reduce greenhouse gas emissions. This carbon cycle maintains the balance of carbon dioxide in the atmosphere when using ethanol as a fuel.



Why make your own fuel?
Because you can!

Alcohol is a remarkable substance: it gives us pleasure, can be used as medicine, and has many commercial uses, including automotive and aviation fuel. I like to think of it as "sunlight in a bottle". You can get better performance from your engine, and it doesn't pollute! It has been used in racing engines in the Indianapolis 500 for over 80 years!



The distillation column is separate from the boiler, and the coils are inside the still.

I first got interested in alcohol as an alternative to petroleum after reading an article in Mother Earth News, about someone making ethanol from corn. He used it instead of gasoline to run his pickup truck. I started experimenting in my spare time, and I made my first still, solar powered, which I demonstrated at the Whole Earth celebration fair at UC Davis, that same year.

What really interested me about this was that grain alcohol (ethanol) is a renewable fuel, and also, it is pretty much pollution free, since the by-products of combustion are only water and CO2. Furthermore, it is economical to make, and your car will run cooler, faster, and better on ethanol. And, best of all, you don't have to fight wars in the Middle East to protect it.

The reason I call it "sunlight in a bottle" is because ethanol is a liquid solar fuel which can be used in internal combustion engines. It really is a very concentrated form of sunlight. (Moonshiners call it "white lightining", but for a very different reason.)
Think about it: plants are the world's most advanced solar collectors, and they have been at it for millions of years. Petroleum is fossilized solar energy, but present-day sunlight is stored by plants in the form of sugars and starches. Yeasts are little critters which like to eat sugar and alcohol is their waste product. Yeast organisms convert the sugar into a simpler and more useable form of energy.

You don't have to throw away the internal combustion engine to convert a car to run on alcohol: just some minor adjustments, really. Electric cars will still need to get their power from somewhere (usually the dirty old electrical grid), and they have to carry around a lot of heavy batteries, but only have an effective range of a couple hundred miles.

Alcohol, on the other hand, can give you the same miles per tank of fuel, with the same or better acceleration.

I personally have driven my own cars on it, as well as many others. I have been able to get the same miles per gallon on 160 to 180 proof as I did with gasoline. There is hardly any pollution: no heavy hydrocarbons, so no SMOG. Best of all, I found I had the freedom of driving around on a fuel I had made instead of buying it from fat cat oil barons. I didn't mix the alcohol with gas in those days: I ran it straight.

Now, you can buy a car that is factory ready for alcohol fuel. In some states (mostly in the Midwest) you can buy E85 (85% ethanol, 15% gasoline). The cars these days are made with variable fuel injection technology, which measures the oxygenate content of the fuel (since alcohol, ETOH, contains an oxygen molecule which makes it burn more efficiently when the timing and air/fuel mix are appropriately adjusted by a computer chip that is factory installed.

In fact, over 2 million cars per year in the USA already are set up to run on E85, and no one told us about this. The oil companies know that oil reserves are dwindling, so the technology is gradually adapting. Experts in the ethanol industry predict 20% of the cars will be fueled by ethanol in just 6 to 8 years (and with ethanol production increasing by 12%/yr., we have the capacity to do this.)

E85 is 102 octane. It burns clean and is better for the engine because it burns cooler, with less carbon buildup.

Make your own E85 fuel



If your fed up with the 40% price hike in gasoline these past few months, this guide is for you and especially for those of you who want to make your own fuel. If you have ever made your own beer or wine, or would like to learn, you can ferment any starchy or sugary foods or waste products into a mash that you can distill into 190 proof alcohol. If you are resourceful, you may even find stuff you can use for free. Once fermented, it is not so hard to distill it to 190-proof with a modern still. The real good news is that you may not have to do any mechanical work or changes to your car or truck. It may already be factory ready for E85.

In other pages of this booklet, I talk about how I always used the 160 to 180 proof I made for running my own cars on alcohol, and all ran great on it. I never did any conversion work on these cars, like drilling out the carburetor jets. I could simply change the air/fuel ratio just by pulling out the manual choke a tad. But I sometimes had to deal with water at the bottom of my fuel tank when I switched back and forth from ethanol to gasoline, and I frequently had to replace the fuel filter, because the slightly corrosive nature of the ethanol tended to scour the inside of my fuel tank. This was a minor inconvenience, though, as fuel line filters were cheap and easy to replace in those days. Nowadays, I don't think I could even find my fuel filter, buried under miles of hoses, wires, and other mysterious stuff inside my 2002 model turbocharged engine.

Now, pretty much all modern cars have fuel injection instead of carburetors, which are controlled by a computer chip getting its information about the type of fuel being used from an O2 sensor, so it makes adjustments accordingly. Even though the chip may not be factory programmed for E-85, it can be replaced with a chip programmed for E85. More on this, later. The real big change, however, is that over 2 million cars/year in the USA are now factory ready for E85. So, you may already be driving an E85 car and not know it.

A lot has changed over the past years. Most of the big distilleries, like Archer Daniels Midlands, are still in business. (ADM first started making fuel ethanol due to a direct phone call from

President Jimmy Carter in 1980, asking them if they would consider converting their beverage alcohol production, to help him promote a renewable fuel made from American grown corn. It took them less than a week to say, "Yes!".) They now have many processing plants, each making over 100 million gallons per year of 200-proof ethanol, which they sell to the fuel industry at an enormous profit.

Gasohol was introduced in 1979 (10% ethanol, 90% gasoline), with quite a bit of confusion among consumers over whether or not it would work in their cars. Gasohol had its proponents and its detractors initially, but gradually became so commonplace that the term was dropped. Now, in 2004, over 30% of the gasoline sold in the USA contains ethanol. (But only 2% of the total amount of gasoline we use is alcohol). It is mostly called, unleaded premium.

The use of ethanol as an octane booster is growing all the time, as 20 states now ban MTBE, and more states will soon follow suit--due to the fact that this toxic fuel additive is highly carcinogenic, and has caused widespread contamination of ground water. MTBE will be totally banned in the USA by 2012.

Contrary to popular belief, there are more than 3 grades of gasoline. Exxon, for example, makes over 150 blends, for specific state and regional markets due to regulations, climate, and seasonal temperature variations. Ethanol may be only 2% of the fuel, or as high as 15%, depending on the Oxygenate requirements and standards for vapor pressure in the summer months (alcohol has a lower vapor pressure than gasoline. ETOH (ethanol) also has an O2 molecule, so it partially supplies its own Oxygen for more efficient engine combustion). Today's cars have sensors to match the timing and fuel injection ratios with what you fill the tank with. This means that most cars now are somewhat flexible, but their programming may only be in a range of 0 to 15% ethanol, not all the way to 85%.

It is inevitable that an aftermarket in re-programmed E85 chips will emerge due to the increasing use of ethanol throughout the world (ethanol fuel is now a $5 billion dollar per year market), but I do not know of anyone supplying aftermarket FFV chips at present. There have been a couple people on my online ethanol fuel discussion at Topica who expressed experience in this matter.

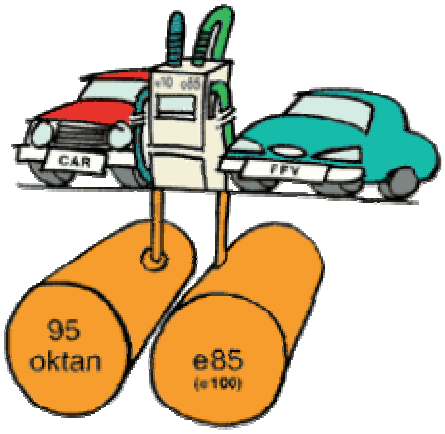
It was really due to Brazil's major switch to ethanol back in the early 1980s that required Ford, GM, VW and Fiat to start making cars that would run on 180 proof, wet alcohol.

According to Joao Alvarez Filho, a Volkswagen plant manager in Brazil, "The new Brazilian models can run on just gasoline, or 100 percent alcohol, or any proportion mix of the two," The company prefers to call this innovation, Total Flex, to reflect the true range of consumer options. The big difference in FFVs in Brazil as compared with those in the USA is that the Brazilian cars can also adjust to wet or hydrous alcohol down to about 160 proof, or the slightly more expensive 100% alcohol sold at the pumps. Alcohol generally sells for about $1.00 less per gallon than gasoline. This gives drivers the flexibility of buying whatever is cheapest at the pumps.

A similar thing is happening in Sweden, where Ford found last year that the flexible fueled Ford Focus outsells the gasoline (petrol) models four to one. Sweden also has over 400 buses that run on an ethanol/diesel blend. In November 1997, Sweden introduced the first blending pump in Europe. You can drive up to one of these many blending pumps throughout the country, and set the percentage of ethanol you want mixed in with your petrol. They provide a tank with 95 octane petrol with another tank of pure ethanol, and the pump blends the two per your order. In this manner a flexi-fuel car can be filled with E85, and a normal car can be filled with any mix from E5 to E25. In the rest of the EU, ethanol now has a low tax advantage, and ethanol is being introduced in slowly increasing incremental amounts.

New GM models--the Tahoe, Suburban, and the Yukon-- all come standard with Flex Fuel capabilities. These alcohol powered vehicles are all made in Wisconsin, a fact that the current governor, Jim Doyle, is proud of. They provide flexibility to fuel with E85, gasoline or any percentage combination of the two.

In Sweden, fuel pumps mix desired ethanol content



Swedish Flexi-fuel pumps mix gas and ethanol for you!

This car has 306,000 miles on it using E85 fuel.



1990 Buick was converted with a computer chip!

A 1990 Buick, converted just by changing out the computer chip that controls the fuel injection and timing. Iowa, where E85 can be bought at 7 or 8 different pumps throughout the state (Iowa is a big corn-ethanol producer).

Most fuel injected cars now have an O2 sensor that detects the oxygen content of the fuel and varies the injection and timing according, since O2 content can vary from one fill-up to the next. He still has the original chip if he ever wants to convert back to running straight gasoline (he has to unscrew the glove box lining to get to this chip, under the dashboard.

E85 Burns so clean, even with over 306,000 miles on this car now, it can easily get another 100,000 miles on this engine, no problem! The E85 is usually about 30 cents a gallon lower than gasoline. The Federal tax incentives for ethanol fuel are supposed to be passed on to the

consumer: so really, the prices should be even lower than they are (the gas retailers, in most cases, keep this money).

This vehicle comes factory ready for E85!



Ford Explorer Sport

You may be already driving a Flexible Fuel Vehicle and not know it!

FFVs (Flexible Fuel Vehicles), factory ready to use E-85, are widely available. Approximately 2 million FFVs have already been sold in the United States, even though many buyers are completely unaware that they use E85 fuel (85% Ethanol). This is according to the National Ethanol Vehicle Coalition. Check your owner's manual, visit with your dealer, or see this list of current model year FFVs to determine if you drive a vehicle that can fuel with E85. Here is a list of car models currently available as flexible fuel vehicles.

http://www.eere.energy.gov/cleancities/progs/afdc/search_type.cgi?1|E85_GSLN

This related link takes you to a site where you can search vehicles made in year 2000 or later to see if they are already considered an FFV vehicle.

http://www.eere.energy.gov/cleancities/afdc/afv/models.html

Here is the root link for this site.

http://www.eere.energy.gov/cleancities/

Also you can buy a used FFV that was previously used as a fleet vehicle, at a considerably reduced price. These tend to be in excellent condition, but may have high mileage.

You can try the General Services Administration (GSA), which leases vehicles to federal government agencies. When these government AFVs (alternative fuel vehicles, as they are also called) are traded for newer models, GSA Fleet Vehicle Sales auctions them. GSA resale vehicles are auctioned to the highest bidder at regional GSA events held primarily between April and October. More auction information on the GSA can be found on its Web site,

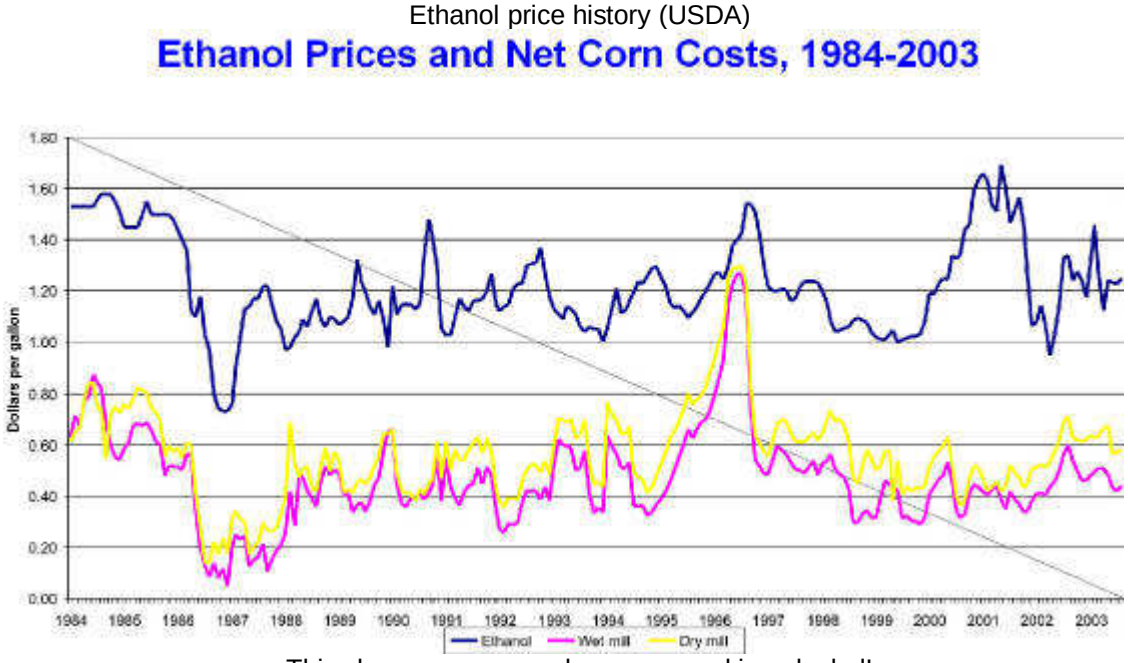
http://www.autoauctions.gsa.gov/

Another factory ready E85 vehicle!



2002 Dodge Minivan

Ethanol price history (USDA)



This shows you can make money making alcohol!

Using dry corn to make ethanol

The clear message at this years Fuel Ethanol Workshop in Madison, Wisconsin (June 2004) is that corn is the predominant crop for ethanol. It is quite economically advantageous: it is 72 to 74% starch, and the spent grain after fermentation and distilling can be fed wet or dry to cows and other livestock. Corn is quite available without causing a shortage in food supplies, since the protein content is a valuable end product earning more than the original corn. Even so, the total US corn crop could only supply about 20% of our gasoline needs, which are massive. However, if we switched to higher mileage models, we could meet perhaps meet 40% of out fuel needs with corn. The U.S. produced 1.4 billion gallons of ethanol in 1998, and over 3 billion gallons in 2003, 90% of which is made from corn. U.S. ethanol production has been growing 12 percent each year since 1980.

In Canada, barley is the predominant grain used for ethanol production. While the starch content is only 50% as opposed to 72% for corn, the price is 20% lower, and the resulting DDG has a higher protein content and therefore yields a higher price. Canada grows more barley and wheat than corn, so it makes sense to use this as a fuel source, just as Brazil uses sugar cane, since this is a major crop in Brazil.

OK, lets look at the basics of making your own E85 from corn. If you are buying it in 100 lb sacks, you will be paying a rate probably 2 or 3 times higher than what the big distilleries are paying; size is everything. They pay anywhere from $2.30/bushel to $3.30/bushel. A bushel is 56 pounds. So this is a variation between $4.10 per 100 pounds (cwt) and $5.89/hundred pounds. The following analysis is courtesy of USDA, ((2003) when Ethanol was selling for $1.37/gallon and gasoline was about the same.

Corn to ethanol:
Corn 1 bushel= -$2.11
Ethanol 2.8 gallons= +$3.85
Byproducts,DDGS= +$1.20
CO2(can be sold or used)= + __?_
Value of ethanol & byproducts= +$5.05
Value-added (profit)= +$2.94

Grinding the corn will require some type of grain mill. It needs to be big enough to do the job. Don't try to use a flour mill unless you can change the grind setting--if you grind it as fine as flour, it will tend to clump up when you add water. The big corn to ethanol producers recommend a screening mill with a 7/64th inch screen. In other words, a coarse grind, like corn grits (not flour) is best. Then you need to add water and bring it up to the temperature that is right for the liquefaction enzyme you need to add. If you dont use enzymes, a lot of the 72% of the starch in the corn will not be converted to sugar. Yeast eats sugar, not corn.

The big, 40 million gallon per year producers of ethanol normally buy their enzymes by the tanker load. The one company which will sell a smaller volume is Novozyzme, but the minimum amount is still 264 gallons. On their website, www.novozyme.com

they say, "While other enzymes are delivered in bulk in tankers, Liquozyme SC DS can now be delivered about once a month in a handy tote (Schütz container) containing 1,000 litres (264 gallons). This particular enzyme no longer therefore needs to be transferred into a storage tank." But I would write to them anyway, and see if you can get them to supply you a 5 gallon bucket for "research purposes".

Drying the alcohol and blending it with gasoline

Mashing and fermentation is covered in other areas of this web site, and how to run the still is covered in the 40 pages of instructions I send out with the Charles 803 still blueprints. So, the thing you need to know next for making E85 is that you will need to remove the last 5 or 10% of water by a process called a molecular sieve. I know this sounds technical, but it is pretty simple, and cheap, too. A sieve is a strainer. The finer the screen, the finer the final product will be, as when you are sifting flower to remove any clumps or large particles. You can buy Zeolyle, which is a granulated product that will absorb water but not the slightly larger ethanol molecules. You need to specify that you want to buy the 3 A size (3 angstrom), as this is what you need for making 200 proof ethanol. Buy Type 3A in 10lb bags (looks like a small pea gravel) it is only a couple of bucks and it works very well to dehydrate the ethanol. We mix about 5 lbs in a 5 gallon can and let it sit with the ethanol overnight and pour the dehydrated ethanol through a screen, into another can the next day. To get the water out of the zeolite we just broil it on the backyard grill - it is reusable indefinitely. Or, you can dry it in the sun by spreading it on a tarp in the summer months.

http://www.thomasregister.com/olc/adcoa/molecula.htm

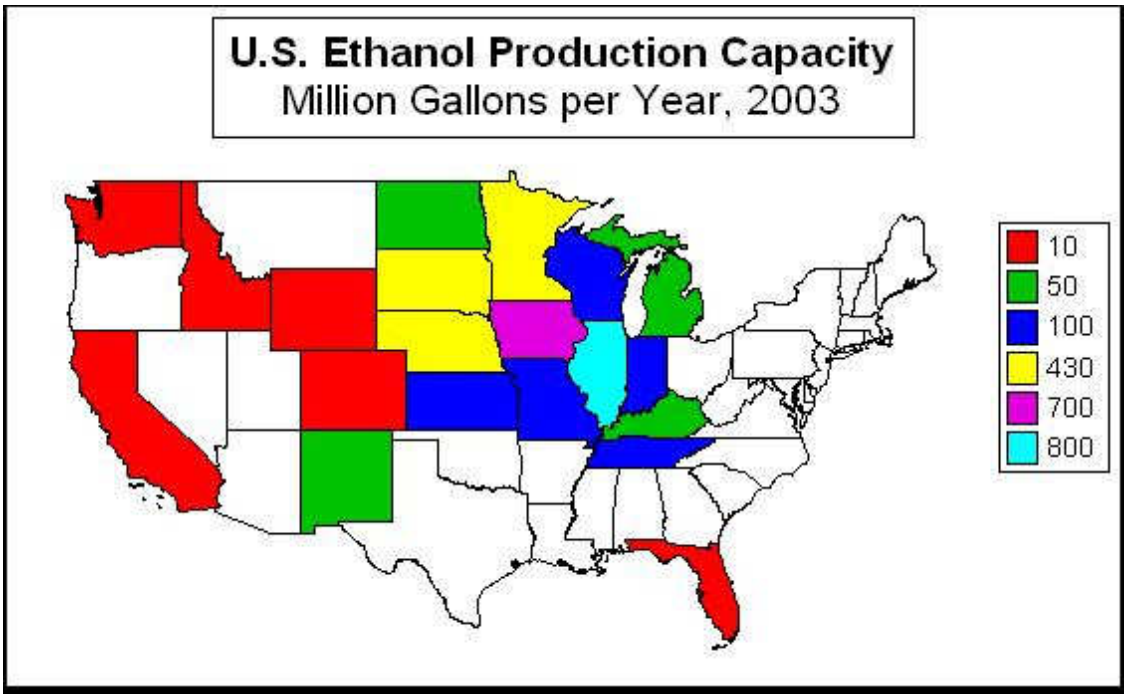
Finally, you measure that you do really have 200 proof with a hydrometer. If you still have some water in your alcohol, it will separate out and settle to the bottom when you mix it with gasoline.

Also, you should strain your 200 proof through a fine screen just to make sure you don't have any zeolite particles that will clog up your fuel filter.

Because of ATF regulations, you will need to add a little bit of gasoline to denature any alcohol you have sitting around. Just 2 to 5% is enough to do the trick. This way, if you ever do get a surprise visit from the ATF (since they know about your still because of the Fuel distillation permit you took out), they can see right away that you are making fuel, not drinking alcohol.

Now, as for adding the gasoline to the ethanol to make E85, even if the car you are driving is listed an this website as an E85 flexible fuel vehicle, be sure to check your owners' manual or with your dealer to make sure you got the model with the right computer chip that will handle E85. I suggest you just wait until you have exactly one half a tank of gasoline in your car, then fill up the rest of the way with the denatured 200 proof you made. This is because it may take a full tank of fuel for the car's computer to fully adjust to the new fuel mix. In the summer you can measure and blend your fuel so you have exactly 85% ethanol and 15% gasoline, but in the winter, I suggest that you do not run greater than 50% ethanol so that you don't have any problems starting your engine on cold mornings.

That's it. You are on you way to fuel independence. You should make up a bumper sticker or better, a decal which then identifies your car or truck as an alcohol powered vehicle so you get to drive it in the commuter express lanes.



US Ethanol Production in millions gallons per year (USDA)

Ethanol In the News

Washington, DC-*The Renewable Fuels Association (RFA) announced Wednesday, Sept. 8, that the U.S. ethanol industry set an all-time monthly production record in June of 222,000 barrels per day (b/d), according to data released by the U.S. Energy Information Administration (EIA).
June was the ninth consecutive all-time monthly production record.

Production was up nearly 23 percent compared to last June when 181,000 b/d of ethanol were produced.

The ethanol industry is expected to produce more than 3.3 billion gallons in 2004, up from 2.81 billion gallons in 2003.

Currently, 81 ethanol plants have the capacity to produce more than 3.4 billion gallons annually.

Ten additional plants are under construction.

Ethanol Fuel Cell technology

The May 2004 issue of Scientific American has a great article on Fuel Cells and Hydrogen. What is quite interesting is that Ethanol is rated in this article (chart on page 71) as the cleanest of all possible available fuels when actually used in a motor vehicle. This is because an ethanol fuel cell is starting out with a clean renewable fuel, so you aren't having to figure in the "dirty electricity" used to produce pure hydrogen for use as a fuel. For more info on ETOH in fuel cells, follow this link:

http://running_on_alcohol.tripod.com/id30.html

MAKING ETHANOL FROM CELLULOSE NOW COMMERCIALLY VIABLE?

Iogen holds patents on GMO yeasts for this process



Shell announces they can turn straw into fuel.

Bonn, Germany-- June 1, 2004

First cellulose ethanol demonstration in European vehicles

Shell Global Solutions International B.V. and Iogen Corporation, together with Volkswagen and DaimlerChrysler, announced today that courtesy vehicles at the 'International Conference for Renewable Energies' (ICRE) will be running on cellulose ethanol blended gasoline.

Delegates to the ICRE will have the opportunity to shuttle between the conference sessions and the Business Forum in either DaimlerChrysler or Volkswagen cars running on this new fuel. The ethanol, made from cereal straw, was provided by Iogen Corporation, and the cars will be clearly labeled for easy identification.

This is the first time that cellulose ethanol has been deployed in Europe and the first time European car manufacturers have made use of this fuel. The cellulose ethanol was shipped to Germany from Iogen's demonstration facility in Canada, and blended with Shell gasoline to meet the EU EN228 gasoline standard. No vehicle adjustments were required.

"We are thrilled with the leadership in advanced bio-fuels demonstrated by Volkswagen and DaimlerChrysler," said Iogen President, Brian Foody. "Cellulose ethanol has major greenhouse gas emission advantages, and we are excited about building a significant clean transportation fuel business in Europe."

Last month, the Canadian firm released the world's first cellulose ethanol for commercial use. Cellulose ethanol is made from the non-food portion of renewable feedstocks, such as wheat straw, and is one of the simplest and most cost effective means of reducing greenhouse gas emissions in transport. Compared with gasoline, ethanol derived from cellulose reduces carbon dioxide emissions by more than 90%.

"Iogen has demonstrated that clean, renewable bio-fuels are no longer a dream, they are a reality," added Duncan MacLeod, Portfolio Manager of Shell's technology division of Shell Global Solutions International B.V.

Iogen owns and operates the world's only cellulose ethanol demonstration facility. The company is working to finalize site locations for commercial plants.

The ability to make ethanol from straw-- rice straw, wheat straw, oat straw, etc is the modern day equivalent of the Holy Grail or the Philosopher's Stone. In a time when barely any new oil fields have been discovered in the past ten year-- and a war in Iraq rages with such anarchistic abandon that it seems unlikely that anyone will be able to pump oil for a the next several year: well, the news that we can run our cars on this "new" fuel seems like a breathe of fresh air. Ethanol burns much cleaner that gasoline, and doesn't add fossilized CO2 to the atmosphere: it is recycling present day CO2.

However, this new development does have Greenpeace and other environmental activists worried: It involves a genetically modified organism: a genetically engineered yeast to convert glucose AND xylose into ethanol.

They added three genes to plain old Saccharomyces yeast so that it can break down both sugars at the same time.

They claim a 30~40% increase in yield. This could be a huge breakthrough--or a huge mistake. Xylose makes up roughly 30~40% of celluloid materials like corn stalks, grass, wood chips,

leaves, etc. In short, a yeast that feeds on xylose can feed on almost anything in the plant kingdom.

Intensive research on cellulose conversion to ethanol previously focused on mechanical, heat and acid hydrolysis techniques, all of which are expensive. Propagating a yeast organism, on the other hand, seems as simple as baking bread or brewing beer.
But don't expect that we small scale distillers will be able to buy this anytime soon. It's the property of Purdue University & they have taken a completely novel approach to marketing this patented technology. They are "leasing" (not selling) the yeast to a Canadian company, Iogen.

http://www.Iogen.ca

Iogen is already producing ethanol and selling it to Petro-Canada for mixing with gas. They are claiming 75 Gallons per ton of straw, with roughly 2/3 of the straw being converted.

It is interesting that Iogen and Shell chose to announce this product to the world in Europe, which historically has been actively fighting any GMO products. Just a week later in Madison, Wisconsin, the 20th annual Fuel Ethanol Workshop had over 1500 ethanol industry attendees, including Iogen--an exhibiting company-- but no mention of this breakthrough was mentioned. Apparently, Iogen, Shell, and Petro-Canada are playing their cards close to their vests. The market for fuel ethanol is established beyond any doubt: it is presently a 3 billion dollar/year industry. By keeping this technology to themselves, a new bio-technology industry promises to be the new Middle East in terms of fuel supply. The other corporate players in this announcement, DaimlerChrysler and VW, have long produced cars that will run or 85% to 100% alcohol--previously only in Brazil, but now in the US, too.

A report titled, “Genetic Engineering—Too good to go wrong?” can be found at

http://archive.greenpeace.org/comms/97/geneng/getoogoo.html

Hydrogen, the "ultimate clean fuel" can be made economically from ethanol made from corn.



Professor Lanny Schmidt stands near an autothermal chemical reactor that converts ethanol to H2

February 13, 2004

MINNEAPOLIS, Minnesota (AP)

Researchers say they have produced hydrogen from ethanol in a prototype reactor small enough and efficient enough to heat small homes and power cars.

The development could help open the way for cleaner-burning technology at home and on the road.

Current methods of producing hydrogen from ethanol require large refineries and copious amounts of fossil fuels, the University of Minnesota researchers said.

The reactor is a relatively tiny 2-foot-high apparatus of tubes and wires that creates hydrogen from corn-based ethanol. A fuel cell, which acts like a battery, then generates power.

"This points to a way to make renewable hydrogen that may be economical and available," said Lanny Schmidt, a chemical engineer who led the study. The work was outlined in Friday's issue

of the journal Science.

Hydrogen power itself is hardly a new idea. Hydrogen fuel cells already propel experimental vehicles and supply power for some buildings. NASA has used them on spacecraft for decades.

But hydrogen is expensive to make and uses fossil fuels. The researchers say their reactor will produce hydrogen exclusively from ethanol and do it cheaply enough so people can buy hydrogen fuel cells for personal use.

They also believe their technology could be used to convert ethanol to hydrogen at fuel stations when cars that run solely on hydrogen enter the mass market.

Hydrogen does not emit any pollution or greenhouse gases. But unlike oil or coal, hydrogen must be produced -- there are no natural stores of it waiting to be pumped or dug out of the ground.

The new technology holds economic potential for Midwest farmers, who are leaders in the production of corn-based ethanol.

George Sverdrup, a technology manager at the National Renewable Energy Laboratory, said he was encouraged by the research. "When hydrogen takes a foothold and penetrates the marketplace, it will probably come from a variety of sources and be produced by a variety of techniques," he said. "So this particular advance and technology that Minnesota is reporting on would be one component in a big system."

The Minnesota researchers envision people buying ethanol to power the small fuel cell in their basements.

Wyoming Ethanol to expand Torrington facility

Torrington, Wyoming, Nov. 26, 2003

"Renova Energy, Inc., the Oklahoma-based parent company of Wyoming Ethanol, announced Tuesday that the Torrington facility will proceed with its plans for expansion from a production capacity of five million gallons annually to 10 million gallons.

This is good news for Wyoming Ethanol and good news for the local economy, said Dan Schwartzkopf, general manger of Wyoming Ethanol. This expansion will increase our grain usage from two million bushels to four million annually which will be a massive benefit for the local farm economy.

Area corn growers are currently in the midst of delivering this years crop to the plant, which began production in 1995, to be processed into fuel-grade ethanol. Ethanol is mixed with gasoline in lieu of lead as an octane booster and to help meet the oxygen requirements mandated by the Clean Air Act of 1990 for the reduction of carbon monoxide emissions. Furthermore, ethanol is increasingly being used in new, cleaner-burning flex-fuel vehicles that operate on a blend of 15 percent gasoline and 85 percent ethanol."

Ethanol racing news



Promising Start at Homestead ends with Gearbox Failure
Homestead, Fla. Sunday, March 02, 2003

HOMESTEAD, FLA., MARCH 2 -- Ethanol-backed driver Paul Dana ran as high as eighth and finished 13th in the opening round of the Indy Racing League's Infiniti Pro Series today, dropping out after 48 of the 67 scheduled laps with a gearbox failure.

Dana started the weekend strong, posting consistent top-five practice times in the No. 24 Ethanol/Team ISI Dallara/Infiniti/Firestone entry, including posting the fastest time in Friday afternoon's session.

However, the team suffered a major setback when Dana crashed in qualifying, forcing him to start towards the back of the grid and ultimately leading to the mechanical problem.

"The good news is we were consistently on the pace and we had a car that was competitive enough to win," Dana said. "The crew at Kenn Hardley Racing did a phenomenal job preparing the car."

Next up for the Ethanol team is Round 2 at Phoenix International Raceway on March 22. Additional series information is available at www.indyproseries.com.

The ethanol team's participation in the Infiniti Pro Series was created through the collaboration of companies within the fast-growing ethanol industry. The primary sponsor is the design and construction firm Fagen, Inc. Joining Fagen as major associate sponsors are the engineering firms ICM Inc. and Broin Companies. The program receives promotional support from the American Coalition for Ethanol.
Ethanol Products is also a supporter.

New York's First E85 Pump (November 2002)

A truckload of the winter blend of E85 fuel was delivered to the first E85 tank in New York on Friday, November 1, 2002! The clean fuel is pumped at the New York State Thruway Authority's service depot on Walden Avenue in Cheektowaga and is open to state vehicles.

E85, by definition, is a blend of 85 percent ethanol and 15 percent gasol transportation fuel.

The New York State Thruway Authority has over 100 Ford Taurus flexible-fuel-vehicles. These vehicles can use any combination of gasoline or ethanol - from 100 percent unleaded gasoline to percent ethanol. The E85 compatible vehicles are sold at no extra cost to the consumer whereas compressed natural gas vehicle can sell at almost $5,000 more than the regular gasoline powered vehicle.

Raymond Hull, the Director of Equipment and Inventory Management for Thruway Authority is quoted as stating "We are complying with the EPAct mandate of having the alternative fuel vehicles but fueling the Taurus' with unleaded fuel is negating our goal of reducing pollution."

NOCO Energy Corporation graciously dedicated their time towards this project. They also delivered the Thruway Authority's first load of E85. The New York State Corn Growers Association has been working for several years to encourage the use of E85 in the State.

This was definitely a step in the right direction!

RIO DE JANEIRO, Aug 26, 2003 (IPS) - Brazil's automotive industry, which had made major strides in fuel alcohol use as a means to confront the oil crisis of the 1970s, is taking yet another

big step, manufacturing cars that run on gasoline, alcohol or a mix of the two -- and maintaining the same level of vehicle performance.

Volkswagen and General Motors put the first dual fuel vehicles on the market here in April and June, respectively, but the technological innovation is a product of Brazilian industry.

"The result benefits the environment, because reducing gasoline consumption and increasing alcohol use means lower emissions of carbon dioxide, a greenhouse gas that contributes to global warming," Manuel Paulo de Toledo, engineering and inspection manager for the Sao Paulo state technology and environment entity CETESB, told Tierramérica.

Substituting a fossil fuel with a plant-based renewable fuel is the correct route to take, especially for curbing climate change, agrees Eduardo Quartim, project coordinator at the Ecoar Institute, a Sao Paulo environmental group.

Furthermore, explained CETESB's Toledo, alcohol production creates economic and social benefits for Brazil because it generates employment and gives the rural population a reason to stay in the countryside.

Sugar cane, the raw material for alcohol, absorbs as much or more carbon dioxide than what is emitted by alcohol combustion. And sugar cane by-products, like the pulp and sediments, are used to generate electricity and as fertiliser.

The bi-fuel automobile gives Brazil greater opportunities to export vehicles, alcohol and automotive technology. Several countries, including the United States, China and Canada, already consume gasoline with alcohol added.

There are nearly two million flex fuel cars in the United States, but there the process is different because they use a mix with a maximum of 85 percent alcohol, which obligates a minimum of 15 percent gasoline, noted Joao Alvarez Filho, Volkswagen-Brazil manager for engines and transmission.

The new Brazilian models can run on just gasoline, or 100 percent alcohol, or any proportion mix of the two, he said in a conversation with Tierramérica. The company prefers to call this innovation total flex, to reflect the true range of consumer options.

The Brazilian advantage was to develop the dual fuel approach based on cars that run exclusively on alcohol, which the country has produced for more than 25 years, a pioneer in the technology.

As of July, 6,100 of these new cars had been sold in Brazil, and buyer satisfaction is high, but it is too early to predict just how far the market for total flex vehicles will go.

Some experts believe that in the long term all Brazilian cars will be bifuel. But another possibility is that the dual fuel will kill the alcohol-only engine.

Volkswagen began to develop the new cars four years ago, with the sole objective of allowing users complete freedom in choosing fuels, said Alvarez.

But the new car is also a response to drivers' worries about alcohol supplies. Alcohol-fuelled cars conquered the Brazilian market in the 1980s, and represented more than 90 percent of car manufacturing within a few years. Cheap alcohol and expensive gasoline pushed this trend.

But alcohol shortages in 1989 and 1990 sharply undermined the popularity of the new fuel. Sales of alcohol-powered cars plummeted to less than one percent of total vehicle sales.

Also contributing to the decline was the fact that petroleum prices fell, and that the state-owned oil giant Petrobrás, a monopoly at the time, wanted to sell within Brazil the gasoline that it was exporting at a loss, says Alfred Szwarc, technical consultant for the Sugar Cane Agro-Industry Union, an organisation of Brazil's major sugar and alcohol producers.

Now the bifuel car has emerged because petroleum prices have gone up again, with the international price at 25 to 30 dollars a barrel, more than twice what was 13 or 14 years ago, Szwarc noted in a Tierramérica interview.

The fact that dual fuel vehicles are on the market is helping consumers get past their hesitations that arose from alcohol-only motors. Drivers are no longer subject to shortages or high prices of one fuel or the other, because they can always use the cheaper one.

Frequently Asked Questions (FAQ)

How do I start?



Q. Where can I get plans for an ethanol still?

A. Blueprints and instructions inclosed in “Guide 1” for the ethanol still that will make 5 gallons or more an hour of 180-proof ethanol on the first run, every run. It is only 5 feet high and weighs only 28 lbs (13kg).

This is an advanced fourth-generation design. It is not a toy for making drinking alcohol: this is a serious tool for making your own fuel.

Q. Can I make this still myself?

A. Yes -- if you are handy with copper plumbing tools and techniques. You'll find the blueprints and written instructions to be quite thorough in helping you through all parts of assembly. The instructions are very precise and include photos to show you the whole assembly process. But it helps if you have an experienced hand to solder the pipes properly.(Get a friend to help you). The

instructions include material on how to solder properly--This is a relatively easy and satisfying thing to learn.

The plans contain the complete list of materials, detailed drawings of the construction procedures, and some alternative methods of heating and running the still. It also includes several pages describing how to adjust and run the still, with variations for different feedstocks and fuel sources.

Q. How much will the still cost to build?

A. It will cost you about $400 to $600 to build the still-- less, if you're good at scavenging parts and components, tanks, boilers, old plumbing fittings, etc. You can scavenge a lot of the other materials on the materials list, but if you want the still to work right, you need to build it exactly as shown on the blueprints. This is a fourth-generation design, and it is very efficient.

Q. How long will it take to build the still?

A. I used to teach a still-building class over a two-day weekend, which included a full day of building and completing a still. It may take you a month just to get all your components together, and then you can put it together in one or two good weekends.

Invite a friend over to help. Soon, you'll want to have a still firing event with your friends showing off your new state of the art still! Nothing makes you feel more self-reliant than running a car, motorcycle, or even a lawn mower on fuel you've made yourself!

Q. What's the production rate?

A. If you have 50 gallons of beer at a 5% alcohol content (which is about what you get working with barley or wheat) you end up with a little over 5 gallons of high proof (0.05 x 50 gal / 0.9 = 5.5 gal of 180 proof). With dry corn, you can easily get twice as much alcohol from the same amount of grain.

It takes about an hour to get this beer up to boiling temperature, and just a little over an hour to distill it. So, if you count just what comes out of the still once your boiler is running, you get about 4.5 to 5 gallons per hour of high proof!

You can see that to be efficient you will want to start with a minimum of 100 gallons, hopefully at a 10% sugar concentration, to get 10 gallons of fuel.

If you run the still at full capacity (it is designed to handle a 500-gallon boiler), you can produce 5 to 7 gallons per hour of 180 proof fuel.
You can even run two stills in parallel if you want 14 gallons per hour. You don't want a large batch to go bad because you didn't get around to distilling it, if you aren't fully set up for running the still. So, start small and know what you are doing before trying to ferment and run large batches.

Q. How much does it cost to produce 1 gallon of ethanol?

A. If you do this on a large enough scale, it will cost anywhere form $0.95/gallon to $1.40/gal to make the alcohol, depending on your feedstock. Look at my web pages, "Mashing and Fermentation" and also, "Molasses and Rum ".

You will also have animal feed by-products which you can sell to reduce the total cost by another $0.40/gal.

Q. What do I do once I have a still set up?

A. First you need a good source of feedstock, that is, a good source of sugar or starch (carbohydrates) which can be fermented in the same process with which you make beer or wine.

You aren't going to drink it, so it can be somewhat contaminated. *Waste fruit from a supermarket trash bin can be a reliable, on-going source of fuel!* Another good source is a commercial bakery.

Realistically, it's best to do all this on a farm where you have access to hammermills, large tanks, and various means of handling large amounts of feedstock (and the resultant waste).

Feedstocks: corn (stocks, cobs, and all, preferably not dried) are good, as are sugar beets, jerusalem artichokes, rotten apples, grape skins from a winery, and much more.

As for fermentation, this is basically the same process as for making beer or wine, except that you don't have to worry about the taste, since you aren't going to drink this stuff.

Q. Is it easy to learn how to make ethanol?

A. It's not rocket science, but there is quite a lot to learn. Running a still does require some knowledge of the whole process. You really need to read a couple of books on the subject, which may or may not be out of print.

Q. How corrosive is ethanol to fuel system parts and how have you addressed this problem?

A. Ethanol is somewhat corrosive to certain rubber and cork materials found in older cars with carburetors. But new cars built in the past ten years are made with new materials that are unaffected by ethanol, since it is now found in over 30% of the gasoline we buy. Or, if you start with an old car, take the carbuerator apart and soak various parts in some white lighting for a few days. Look for signs of deterioration and replace what you have to.

Ethanol may also eat the coating inside most older gas tanks, so a separate plastic cross-link polyethylene tank is recommended (but not necessary). I just put my alcohol in a standard gas tank and then clean the fuel filter occasionally. If you make your own E85, and your car is listed as a flexible fuel vehicle (2 million American cars per year are now made this way) then you have no worries.

Q. How do you combat the problem of hard starting on cold days?

A. If you are making your own E85, I suggest you make E50 for winter and Spring use, and only make E85 when it doesn't drop below freezing temperatures at night. On old cars, our most common method is to salvage an old windshield washer pump from a junk yard and rig it up so you can push a button on cold mornings to squirt a small shot of gasoline into the carburetor.

Q. What is the octane rating of 180 proof ethanol?

A. 180 proof ethanol is equivalent to 106 octane. You would need to modify your engine to run a fuel that is 90% alcohol and 10% water. This involves carburation (or fuel injection) and timing. But if you buy or own an E85 car, these adjustments are done automatically, due to a new computer chip and Oxygen sensor in the fuel line.

Q. What engine modifications are required? Perhaps none at all--the car you drive may already be factory-ready for E-85 (85% ethanol) which you can make yourself.

A. In the old days (pre-1990), engines had carbeurators, and you had to drill out the jets or install larger jets.

In several vehicles I've owned, I never changed the jets at all: I just pulled out the choke a little bit. This allows you to change the air-fuel mix to where it sounds best and runs good.

Don't let any of this stop you -- we need to get people out there making their own fuel and showing the oil giants that we aren't dependent on their whims. The newer engines have an O2 sensor and a computerized controller that automatically adjusts the fuel injectors to the type of fuel

Q. Does ethanol have a shelf life and will it lose its octane level like gasoline does?

A. If it is sealed it will last for years and years. If opened to the atmosphere, it will suck moisture out of the air and get a little bit diluted.

Q. Does ethanol go rotten in time like gasoline and produce varnish?

A. No. Alcohol is what preserves your wine and gets better as the years go by. But you need to start with triple distilled alcohol as made in the still I designed so that the fusil oils and other impurities are removed. But you must keep it sealed, as alcohol is hygroscopic--this means it will suck the moisture out of the air. So keep it capped so it doesn't get diluted. Store it in glass, but plastic milk bottles are quite stable and the alcohol will keep OK.

Q. How difficult/expensive is the US licensing process for making alcohol?

A. Getting a licence from the Bureau of Alcohol, Tobacco, and Firearms (BATF) is not difficult, and only takes about a month.

Q. Is there a limit to how much ethanol can be produced for individual use?

A. In the USA, you can make as much as you like. (You will have less hassle if you tell them you are applying for the small scale production plant of less than 10,000 gallons per year). The only requirement is that you report how much you make and that you denature it (make it poisonous to drink). Isn't that a strange way of making sure people don't drink it? They must think it is better to kill folks than to let a few people get off without paying the tax. This law was established back in the days of prohibition.

Q. Do you have any similar information on butanol?

A. Butanol is a pretty exotic fuel, not something you want to make in your backyard, as the smell is truly horrible -- not so much the fuel itself, but the cellulose-eating bacteria, like very smelly socks times 1,000!

Butanol is a very interesting fuel, though, as it can be made from rice straw which is normally just burned off, and you don't have to modify your engine as it is completely compatible with gasoline, as well as miscible (it will mix with) with gasoline.

Better to stick with building a still and making ethanol. It is clean and there is no pollution, and the neighbors won't complain about the smell.

Q. The part of the process that concerns me is the mashing and fermentation. Is there any way to simplify or automate these stages?

A. The California Department of Agriculture ran a still-building competion a few years back and awarded a prize to Floyd S. Butterfield, a farmer who automated pretty much the whole process. He used sludge pumps to circulate the mash during the fermentation and also the cooking processes, which keeps the solids from stacking up at the bottom of the cooker and burning

during the process of boiling (cooking) the mash to create the steam vapors you are feeding into the still.

There are lots of books about commercial alcohol production, but you may have to go to an agricultural university library to find them. The enology (wine making) department at Univerity of California, Davis is a world leader in the field and has extensive resources on ethanol production, as does the California Department of Agriculture.

Q. Can I drive my alternative fuel vehicle (AFV) in high occupancy vehicle (HOV) carpool lanes, regardless of the number of passengers?

A. The simple answer is "yes"in some states. The use of AFVs in HOV lanes is addressed in Section 102 (a) of title 23, United States Code. The following states have provisions that allow AFVs in HOV lanes: AZ, CA, CO, DC, GA, UT, VA

To see if you can drive your alcohol powered vehicle in the HOV lanes, click here:
http://www.afdc.doe.gov/p_single_faq.cgi?10

THE ABC'S OF FUEL ALCOHOL

Q. How much does it cost to produce 1 gallon of ethanol?
A.It will cost about $1.10 to $1.20/gal to make the alcohol from various feed-stocks like corn, barley, potatoes, or Jerusalem artichokes. You will also have by-products which you can sell or use as animal feed, reducing the total cost down to about $.95/gal.

Or, you can make it the cheap and easy way for only $1.20/gallon on a large scale, buying molasses by the ton (if it is a high sugar molasses).

Q. What materials are required to make ethanol once I have a still set up?

A. First, you need a good source of feedstock. By feedstock, I mean a good source of sugar or starch (carbohydrates) which can be fermented in the same process as which you make beer or wine. You aren't going to drink it, so it can be somewhat contaminated: For example, we once made a batch from a weeks' garbage from a low-security prison (one of our CAPFA founders worked there), so he separated it out for us. It was mostly lumpy mashed potatoes and stale bread, and we had to fight off the flies while we ran mixed it with water and dumped it into a larger fermentation tank. Then we covered it with window screen to keep the flies away.

Another time we used 5 year old dehydrated prunes, which I soaked for a week to get them soft enough to grind by hand, with a baseball bat. Realistically, you want to do all this on a farm where you have access to hammer-mills, large tanks, and various means of handling large amounts of feedstock (and the resultant waste). Corn (dry kernels) is one of the best, as it is over 70% starch. Also,you can use sugar beets, Jerusalem artichokes, rotten apples, grape skins from a winery, and much more. Molasses works great, too.

Q. Can you buy a car already set up to run on Ethanol?

A. There are lots of cars you can buy that are already set up for E-85: Ford Taurus, Chrysler Voyager Minivan, Ford Explorer, dodge Ram pickups and Mazda 3000 pickups, and much more.

Q. How much feedstock does it take to produce one gallon of ethanol?

A. 180-proof is 90% pure ethanol. To make it, start out with something cheap and readily available to make your own beer. I suggest you start with ordinary corn, wheat or barley, and start by following an ordinary recipe for making beer at home. Corn is best, with more starch. Grind it with a 1/8th inch screen mill (if it is too small, it is like flour and will ball up in water, so a course grind is better). For starters, use two 50-pound sacks of grain (40 kg). (I don't suggest buying this on a regular basis, but just for your first run if you dont have anything else available for free).

If you make 80 litres (20 gallons) of beer at a 10% alcohol content (which is about what you get working with corn) you end up with a little over 2 gallons of high proof (.10 x 20 gal/.9 = 2.2 gal of 180 proof).

In metric, this is .1 x 80 ltr/.9 = 8.9 litres.

You will soon discover that for making fuel, you will want to start with a minimum of 100 gallons, hopefully at a 10% sugar concentration, to get 10 gallons of fuel to be efficient. This is not a project for the your kitchen, as it will get a bit messy, Better to do it in the garage.

Q. Can you make ethanol out of straw, grass clippings, or wood chips?

Yes and no. Alcohol is now being made from straw by a Candian company, Iogen, which is using a genetically modified organism (GMO),in this case,yeast to do just that.

http://www.alcohol4fuel.com/id37.html

But this yeast product is not for sale and certainly will not be available to small scale producers. Other techniques have been tried--I even have a 25 year old book on making ethanol from sawdust-but they tend to be expensive, dangerous (involving strong acids) and have toxic waste products.

Q. Can your still be used to make methanol? Isn't methanol a better fuel than ethanol, which is why it is used for racing?

No. Methanol or "wood alcohol" was made in the 18th and 19th Century by "destructive pyrolysis", which is burning wood chips inside a closed chemical retort container in the absence of Oxygen. This process used 15 times more energy than contained in the end product of methanol, but they were interested in the methanol for other purposes, such as for paint thinners and other chemical needs. Actually almost any still will have small traces of methanol along with the high proof ethnanol. The triple distilling action of the still, will remove most of the methanol, but that doesn't mean it is safe for drinking. If you want to build a still for drinking alcohol, there are a lot of smaller and cheaper stills you can build.

The still is for making moderate quantities or ethanol for use as a fuel. You can make 5 to 8 gallons an hour of 180 proof. If you want to sell your fuel, this is probably too small a still for you, but it is nevertheless a good tool for learning about fuel productions and for experimenting with different feedstocks for fermentation. The thing is, you don't need super pure alcohol if you aren't drinking it. But for the sake of your engine, it is quite good to have high proof, triple-distilled alcohol as made in the still. You may not have removed the all the methanol, but this is a good fuel, and burns clean. The fusil oils and various other impurities have mostly been removed, but

any minor impurities will also burn, much cleaner than gasoline, with no carbon build-up. In fact, ethanol will dissolve build up carbon as it burns, so the end result is a clean engine. Now, as for the question, which is a better fuel, ethanol or methanol, ethanol is clearly the better fuel: it has 38% more available energy (86,000 BTU's per gallon for ethanol, while methanol only has 62,000 BTU's/gallon). Methanol is commonly used for racing as it is a cheap and easily available byproduct of the Natural Gas industry, and is cheaper than ethanol because they don't have to pay the distillation taxes. Ethanol is also used in racing, and the Indie 500 has used this fuel for over 80 years, now. Ethanol is less corrosive than methanol, and burns very clean, with only CO2 and water as the main byproducts of combustion (there is a slight amount of aldyhides in the exhaust, but it is 300% cleaner than burning gasoline.



Polishing the reflux section in preparation for soldering

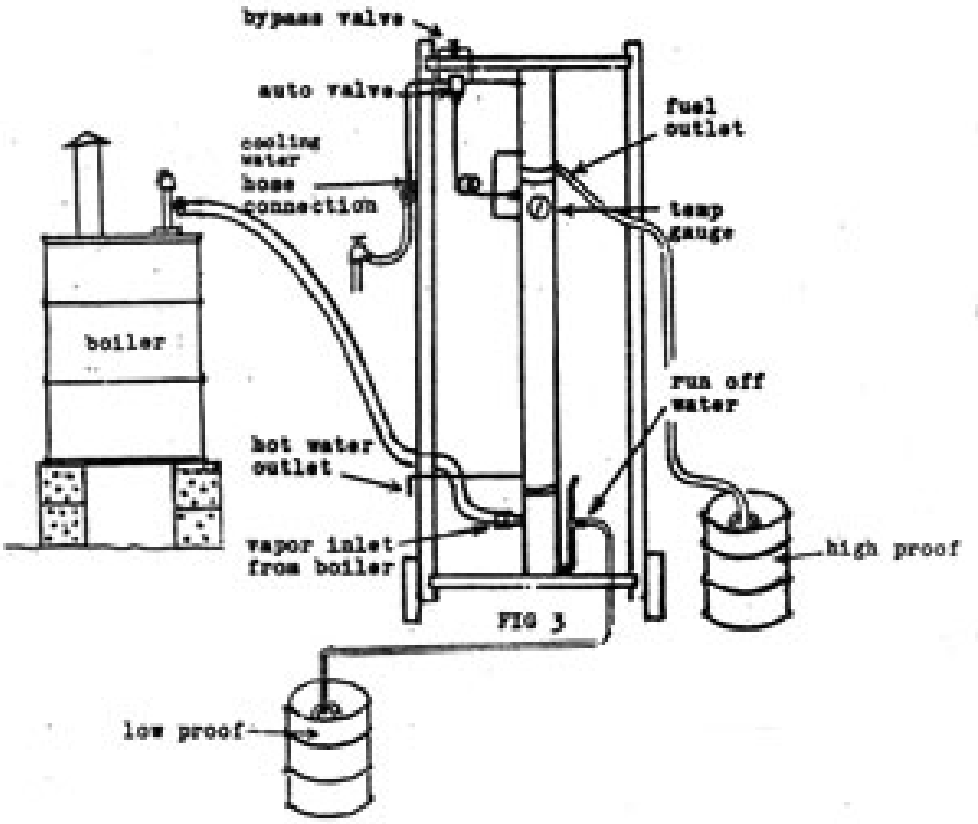


FIG 3

This simple diagram shows a boiler sitting on concrete blocks, with a safety vent at the top of the boiler. The hose routes the hot steam into the bottom section of the three-stage still, with the internal reflux and cooling coils. The high proof alcohol drains out into the glass bottle.



Backyard ethanol

You can make fuel alcohol in your backyard, and many people are doing just that, and running their vehicles on clean-burning alcohol instead of gasoline.

You'll need a still, and you will need to ferment beer, or wine, from corn, barley, kitchen scraps, or even molasses. You can build your own still.

If you have been looking for a true reflux still, this is it! Reflux refers to the up and down action inside the still where the alcohol and water vapors are condensing and re-boiling, as it this process that successfully separates out the pure alcohol from the water. There are many still makers out there who say they have a reflux column type still, and they do not even know the meaning of the word!
Most of them make the biggest mistake made by many generations of still makers: they have the reflux column and condenser permanently attached (and therefore thermally coupled) to the boiler. This means that the only way to control the temperature (which is what controls how high the proof is) is by means of raising or lowering the temperature of the boiler. Perhaps in a laboratory or in your own kitchen, burning propane or natural gas (and thus, burning fuel to make fuel), this can be somewhat controlled. This works OK for making small amounts of drinking alcohol, but if it is fuel your are after, you want to burn scrap wood, or anything you can get cheap or free as a fuel source, because you have to minimise your costs and also be adaptable.

Controlling a boiler pot is a huge bother, and nearly impossible. This is why my still has the distillation column as a separate and easily controlled discreet component.

With a pot still, on the other hand, once the beer solution gets hot enough to boil, it starts to boil fast. At this point, a mere 5 degree (F) change in the temperature of the vapors will result in the final product being only 100 to 120 proof instead of 160 to 180 proof. To get high proof ethanol, you have to be able to control the temperature accurately and quickly within a very narrow 1 degree Fahrenheit range. This is only possible if you physically separate the reflux column from the boiler. Secondly, you have to include an automated control method, such as the automated temperature control valve pictured on my still (located just above where my friend has his hand resting on the left side of the still).

Most home-made stills you will find on the internet are not true reflux still as there is rarely enough internal surface area or thermal mass to stabilise the alcohol vapors to create the turbulent up and down effect of condensing ethanol dropping down and being reheated by upward vapors and a the same time cooling and stripping the ethanol out of the upward-moving vapors. A reflux column needs to be internally packed with a thermally stable packing material. The large reflux columns in a commercial still use ceramic marbles or rashig rings typically.

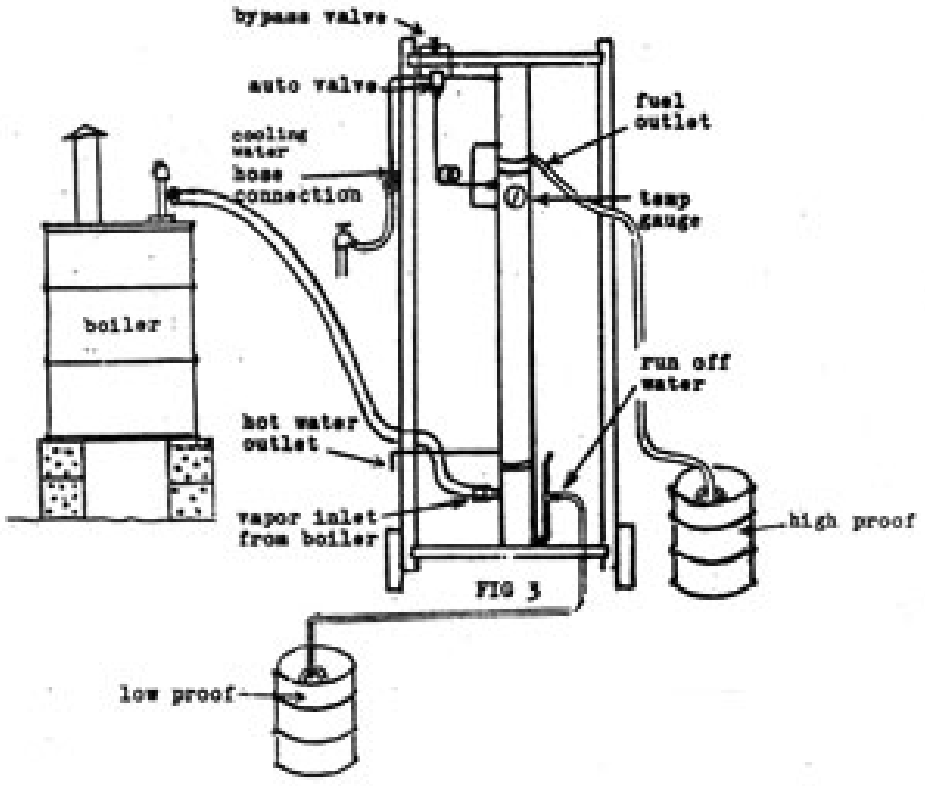


FIG 3






JUN. 13. 2000
7:22



The top section is the condenser section.

RUNNING A STILL.©

"I had organized a pretty big energy fair, as part of a larger Renaissance Fair. We invited another ethanol enthusiast to bring over his VW Rabbit, which he had converted to ETOH for a total sum of about $20.00, and we ended up the weekend, filling it with the ethanol we produced at the fair.

"I also got someone from the National Energy Research Laboratory to bring over and show one of their $30,000 car conversions: a brand new, fuel injected multi-fuel Chevrolet Lumina, which could run on gas, ethanol, or methanol.

"We even had some students from the University of Colorado bring over their photovoltaic racer which had a couple of months earlier participated in the coast-to-coast Solar Challenge.

"This particular still is a very efficient design. It has an automatic temperature control valve, and graduated heat loss via internal water cooling, both of which are keys to consistent proof. It produced 180-proof ethanol on the very first run! It can make 5 gal/hour of 160 to 180-proof, which is a great fuel."

I called a couple of local breweries, because I had been in the hospital only the week before, so I didn't have time to brew up some mash on my own. Boulder Beer donated 60 gallons of fresh beer, in two 30 gallon plastic drums. With the help of a friend, I poured 30 gallons into the 50 gallon metal drum which was supported in a cradle made from another 50 gallon drum which I had "carved" with a cutting torch into a convex shape. I had also scooped out huge air holes for the combustion oxygen needed by the big cast iron propane burner I had scavenged from a very old water heater. I also removed the guts of the pressure regulator on the water heater control valve, as I wanted to be able to turn it way up on high because I wanted boiling water, not just hot water. The cutout barrel support stand was set on top of two concrete blocks, as I had to keep the fire and the heat from the burners well off the grass. I had learned this the hard way by leaving a burned circle on a University lawn a few years, before. I also kept two fire extinguishers handy: not so much because I thought I would need them, but I did have to apply for a special permit from the local fire department in order to run the still. It is so crazy how everyone gets so worried about flames near high proof alcohol, when actually, it has a much, much lower flash point than gasoline vapors. Making alcohol is a relatively safe and clean operation.

You can't really see it in this photo, but there is a black hose coming from the top of the barrel to the bottom, left side of the still, where the steam vapor enters the still. This is shown on the diagram in the left coumn, though.

At the top right of the still, in the picture frame, is the license I received (just in the nick of time) from the Federal Bureau of Alcohol, Tobacco, and Firearms. The 5 gallon glass bottle on the left is where the high proof alcohol is received and stored. Some elses hand is on the garden hose fitting where the cooling water enters the device, and this water came from a faucet on the building 25 meters in back of me, the Boulder City Hall. We made a little under 2 gallons of 180 proof each day, and the total time to do this, from when the beer started boiling, was about 45 minutes. It took a little over 30 minutes to get the water to start boiling. It initially boils at about 85 C, because the alcohol slightly lowers the boiling temperature, but also because Boulder, Colorado is 1,500 meters above sea level. That is a hydrometer laying on the ground, to test the proof of the alcohol. You will need a low proof one for the bear (also called a balling hydrometer) and a high proof one for testing what comes out so you cane make some minor adjustments in the temperature settings. Control the temperature, and you control the proof. It will vary mainly due to ambient temperature: on cold, windy days, you wont need as much water for cooling) and due to the altitude, as mentioned above. The temperature control valve is mounted directly on the front of the wooden support frame, just 30 cm to the right of my friends hand. The water hose is under pressure, and because there is a temperature sensor which leads to a diaphragm on the control valve, it opens and closes very quickly in response to less than a degree C temperature change.

I am predicting a huge increase in petrol prices in May or June, 2002, due to financial world backlash from terrorism and the War on Terrorism. This is going to have a huge ripple effect in the World economy, and it is likely to seriously effect Asian nations worse than the economic crises of 1997. Prices will remain high for about 6 months, or even longer if Bush starts bombing Iraq. My predictions are based on historical trends, and I am old enough to have seen this happen a few times. (I just turned 50 this year). So, the upside of this will be an increased public interest in ethanol and biodiesel. Sometimes it takes a crises to effect real changes. I just hope it doesn't get too bad, but poor countries are always the hardest hit by such economic hard times.

Murphys Law says that if anything can go wrong, it will. In terms of running a still, this means you must pay attention, and follow the following safety warnings, so that you make a still which will not blow up in your face.

Alcohol as a liquid is not dangerous (unless taken internally) but ALCOHOL IN A VAPOR CAN EXPLODE! It would be useless as a fuel if this were not true. That said, petrol (gasoline) is far more dangerous, and yet we use it every day, except generally, not around open fire.

This still is really a lot safer than most batch stills, A: because the boiler can be set up at a distance from the still. And B: because it operates for all practical reasons, pretty much at atmospheric pressure. no internal pressure is allowed to build up. This part is detailed in the next section, on building the boiler.

A pot still is far more dangerous with the reflux column up there on top of the boiler, where the spillage and vapors are directly above open flame or an electrical heating element.

Alcohol does not explode like gasoline. Gas vapors go off with a bang. Alcohol burns more slowly, so when it lights, it goes off with more of a whoosh which may ignite something else. So just keep flammable stuff at a distance.

This still is very small. Don’t let the size fool you. It can produce as little as a quart an hour, or it can get up to several gallons an hour. This is because it operates on vapors from a boiler containing fermented brew. The distilling process actually begins at the boiler. The boiler can be anything from a small pressure cooker to a 1000 gallon boiler.

Distilling is a process by which the alcohol is driven out of the beer by heat. When two liquids are mixed, their boiling point changes to a point between the boiling points of the two liquids. Just where this new boiling point is in terms of exact degrees depends on the concentration of the two components of the liquid.

Vapors mixed together act independently. Because we are starting with a solution containing less than 15% alcohol, a great deal of water will be vaporized as we heat the liquid.

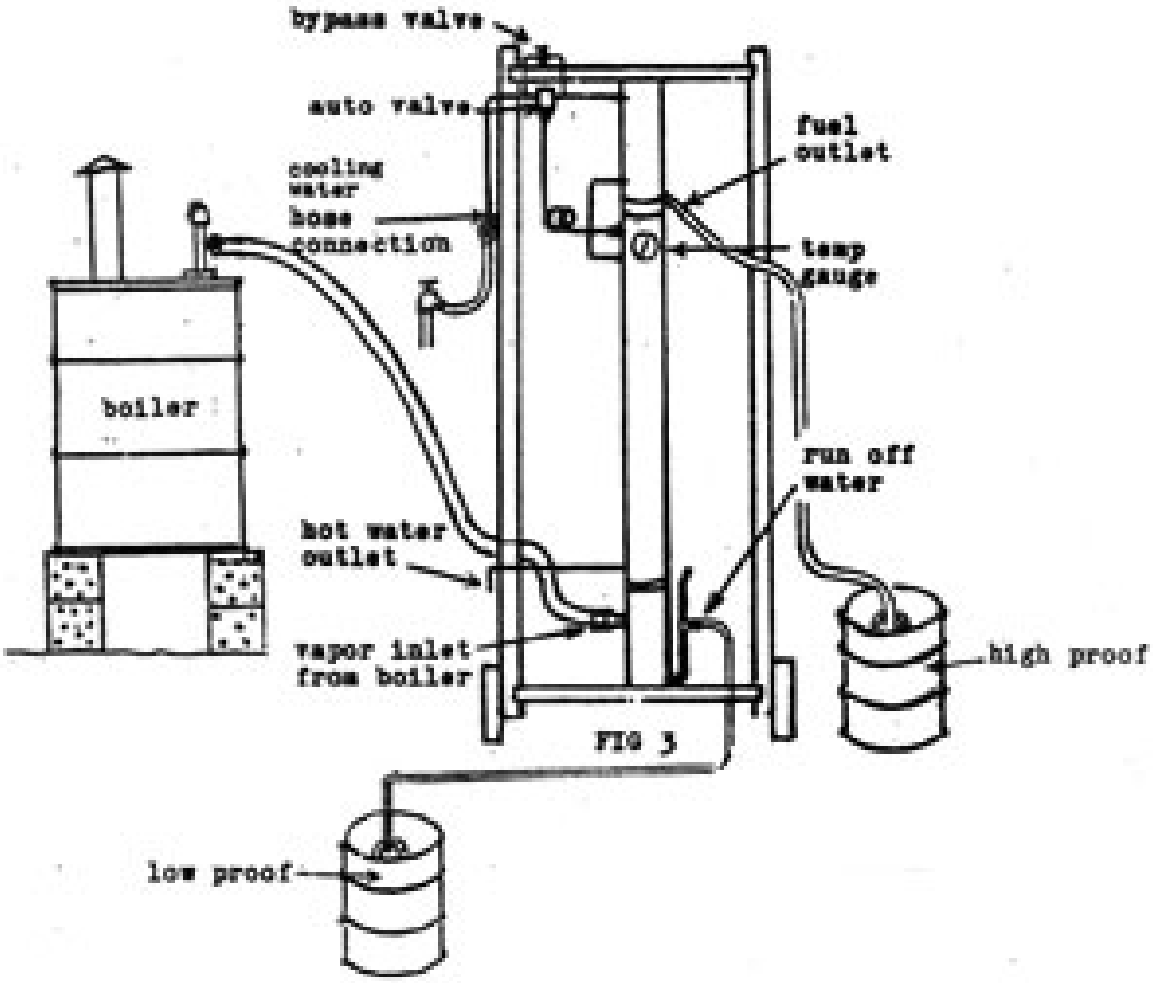


FIG 3

This drawing shows the boiler as a 50-gallon drum standing on end on concrete blocks. This is easy to set up, but is not ideal. It is far better to lay the barrel on its side, as this allows for faster and more efficient heating as the flames warm more of the barrel's surface. This requires driving stakes next to the outside of the blocks so they don't roll outwards due to the weight of the barrel.

Also, the safety release valve is shown at the top of the barrel. This valve is set for releasing steam if it gets above 2 psi. Text below tells you how to make one.



Just behind his hand is a white and black 50 gallon barrel, filled with 40 gallons of beer donated by a local brewery. The garden hose brings cooling water into the automatic temperature valve. The high proof alcohol runs out into the glass bottle at the lower left. Note the similarity between the items shown in the drawing, above, and the actual still. The 6% alcohol beer yielded 2.4 gallons of 160 proof in just over an hour of boiling time!



BUILD YOUR OWN BOILER

The boiler should present the largest liquid surface area possible. Vapor comes out of the liquid only at the surface, so the more surface area, the greater the opportunity for the vapor to leave.

If you are using a 50 gallon oil drum (I like to find a used vegetable oil drum, as there is no smell of petroleum), use it in a horizontal support rather than in a vertical position. This way, there is also more area on which to apply the heat, making a more efficient use of your heat source. For example, with a 200 liter oil drum. If heat is applied to the end of the drum while it stands vertically, the vaporizing surface would be the diameter of the drum. If the drum were lying on its side, the heated surface and the vaporizing surface would be considerably greater. The boiler should be vapor and liquid tight and able to withstand heat and pressure.

The distilling process begins at the boiler and the plumbing from the boiler to the still becomes the first stage of the still. If the piping from the boiler is not insulated, much of the water will condense and run back into the boiler or out through the runoff outlet at the bottom of the column. A slight downward slant from the boiler to the column will prevent the water from draining back to the boiler. This simple plumbing trick will extend the capacity of the still greatly.

REMEMBER: All the still is doing is cleaning the water out of the vapors before condensing them. The higher the proof we want, the more cleaning we want. As soon as the vapors come out of the boiler, any slight cooling will strip out a portion of the vapors.

WARNING: Just as a covered pot will boil over when cooking rice or pasta, this can be a much bigger danger when heating such a big container. The main thing is, never have a completely closed container. While we don't want an open vent like the little hole on many cook-pot lids, as this would release lots of precious alcohol, we do want to blow off steam if it gets above 2 or 3 pounds pressure.

Build your own safety vent:
The cheap and easy way to do this is to put a tin can upside down over a pipe fitting at the highest point of the barrel, with a 1 kg. rock to hold it down. But you will probably lose a

bit of steam, and therefore, precious alcohol this way. I now prefer to use a 2-inch tee fitting with a 2" swing type check valve screwed into the top of the tee. I install this on top of the cooker barrel. Screwed into the side of the tee, a reducer bushing sized to the hose adaptor fitting which feeds the hot steam down through a 5 foot long black radiator hose to the 3/4 inch fitting at the bottom of the distillation column. The swing check valve I install on the top side of this 2 inch tee is a brass swing type check valve (no springs, please) with the direction of flow arrow pointing upwards. It will be normally closed under the weight of the brass plate, but will open up when pressure exceeds about 2 psi. This gives us a safety relief valve for our cooker pot, and if the steam pressure gets too high, say above 2 pounds per square inch, this valve will flap open and closed and relieve the excess pressure before it becomes dangerous. This is safer than buying a steam release valve which is probably set too high to be safe. In the drawing to the above, you can see the safety valve just above where the hose comes off the barrel.

DOUBLER

The doubler is the bottom section of the drawing and where the vapors first come into the still. Here we create a pool of liquid from the stripping above and make the incoming vapors pass through it. This does several things.

1. The vapor heats the pool. In heating the pool the vapor will be cooled and a considerable amount of the water will condense. The reason it is called a doubler is because it was found that just about half the water condenses out every time it passes through one of these pools.
2. The heated pool will be above the boiling point of alcohol so that any alcohol falling from above will be reheated and go back up.

3. This pool will keep any solids that might have reached this point in suspension so that they will flow out in the runoff. This is a very important part of the still, even though it isn't difficult to build. In order to keep the pressure that is built up as the vapor passes through the marbles from forcing the pool out, the pool should be at least seven inches deep. The depth of the pool is set by the trap made by the runoff line.

MARBLE STRIPPER

Most stills will have a vapor stripper section, which may be plates or marbles. The Charles 803 Still combines the two types. There is a plate at the bottom and one at the top of this section with many holes in them. These holes should be at least 3/16 inches in diameter so that the liquid going down will not close the holes and stop the vapors from going up. They should be small enough that the stripper material does not fall through. The plate at the bottom supports the stripper material and the top one distributes the downward flow more evenly.

The first vapors entering the bottom of the still at the doubler will encounter the cooling pool, condensing some of the alcohol, lowering the boiling point of the pool. A 5/8" pipe runs through the stripping material from above the vapor inlet to below the stripper coil inlet to allow some of the vapors to rise and cool quickly and replenish the pool before the boiling point is lowered to below the temperature of the incoming vapors, causing the pool to boil out.

You have just learned the principle behind the big steam columns. They supply steam at the bottom of the column and beer at the top. The plates inside work just like the marbles and the up and down flow begins. This type of still uses live steam to heat up the stripper, which also boils the beer. Either by controlling the amount of steam entering or the rate the beer is pumped into the
column the proof is set. Because heat must be transferred from heat source to water to brew, and because the steam column adds water vapor which must then be condensed, steam columns are large and not very heat efficient.

CONTROL SECTION

This section simply puts a distance between the top of the stripper coil and the condenser to keep the two from affecting each other, and allows us to get some idea of what is happening inside the still. We need some reference temperature so that we can set the proof of the alcohol coming from the condenser.

The middle of the control section will give us a reference temperature. Let us stop for a minute and see what this reference temperature tells us. First, we know that pure alcohol at sea level will boil at 173 degrees F. We don't want the temperature at our reference point below this or we will be condensing much of the alcohol. In order to distill a high proof alcohol the temperature should be as low as possible, in terms of being near the 173 degree condensation point. The automatic valve will control this accurately. Exact temperature depends on altitude and a variety of other factors. The flow of water in the condenser coil needs to be no greater than sufficient to cool the liquid to 100 degrees F. This flow will be determined by the amount of vapor to be condensed and the amount of water in those vapors, which is determined by the temperature of the vapor going in. The flow of water through the stripper will be determined by the proof we want. The more vapor going through the still, the more water needs to flow through the stripper to keep the temperature of this section constant. The cooling water for the reflux section has already been somewhat pre-warmed by its short journey through the condenser. This water is already warmed somewhat, so it is less likely to overstrip or condense alcohol vapor. This coolant water enters at the top and comes out the bottom of the stripper (reflux) coils. The water coming out the bottom 1/4 inch tubing at the bottom of the still will be at very high temperatures. It can be used as a heat source for the distilling room, another room or part of the alcohol production process.

THE MODEL 803 STILL IN OPERATION.

With a thermometer in the liquid area of the boiler, we can watch the temperature rise in the boiler. At some temperature above 173 degrees F, the pipe between the boiler and the still will begin to heat up. The exact temperature at which this happens will depend on the concentration of alcohol in the brew. A low boiling point indicates a high concentration of alcohol. You can follow the vapors by feeling the pipe and still as they warm up.

Remember - The steam starts at the boiler, enters the bottom of the distillation column, and then vapors are being cleaned (the water is removed) as the steam travels upwards.

Soon after the mash starts to boil, the temperature in the control section will start to rise. When this occurs, start a cooling flow of water. If you are controlling the water flow manually, let the temperature rise to around 190 degrees F and hold it there for a couple minutes to start with. You will start to see your first pure alcohol coming out the high proof spout at this point, and this moment is always a very exciting one! But you don't want the condensing section to get too hot, so start your water flowing at the manual bypass valve, if you don't have your automatic valve adjusted to the right temperature, yet. You should adjust your valve only a small amount, say 1/8th to 1/4 of a turn at a time, and watch the dial thermometer to see how the temperature responds. The less vapor flowing through the still, the smaller the change and the slower the reaction will be. But on the other hand, if your mash is boiling full blast, you have to get the cooling water going almost full blast (through the 1/4 inch internal cooling coils) to strip the water out of the hot steam. Be sure you allow time for the change to take place and the proof to level off.

If you have a hydrometer, draw off and save small samples of your high proof alcohol, occasionally into an empty beer bottle, and record the proof and temperature at each test so you can go to that temperature for that proof.

If you have an automatic valve, turn it to the lowest temperature setting. When the control section

temperature stabilizes, slowly turn the valve to a higher temperature until alcohol begins coming out. Let the still stabilize here and check the proof, raise the temperature slightly, stabilize and check the proof and so on until you reach the highest temperature your valve will allow, or the lowest proof you wish to distill. Once you are familiar with the valve, you may set it quickly to get whatever proof you like and it will consistently get that proof.

Dont be surprised if the alcohol starts coming out before you turn the water on. The vapors will condense on the condenser coils as they warm the condenser.

REMEMBER: You are not applying heat in the still. The control temperature is the result of vapor flow. If you don't have any vapor flow, the temperature will not be very high. The more alcohol in the beer, the sooner the vapor begins to flow. If nothing but water ever comes out of the still, there was no alcohol in the brew. Soon after you start distilling, there will be some flow out of the runoff outlet. This will mean that the pool is full and the still is nearly stabilized. Once the pool is full and you have adjusted the temperature to the proof you want, alcohol flow will increase. The up and down flow is established and the pool is flashing the alcohol that reached it back up to the stripper. As long as the heat is being applied to the boiler at an even rate, the vapor is removing all the heat that is being put in.

REMEMBER: The brew is losing alcohol. The smaller the batch or the more heat being applied, the faster this happens.

As the alcohol percentage falls, the temperature in `the boiler will begin to rise. This is because the boiling point of the mixture is approaching that of water. The rise in temperature will be seen in the still also, so little by little more water will have to be sent through the stripper to hold that temperature steady. Watch the boiler temperature closely and record these temperatures and the length of time it takes this rise to occur. The operation of this still is such that the heaviest flow will be at the beginning and slowly taper off until the alcohol flow stops altogether. Check the proof as it gets near the end. If it begins to fall off increase the stripper water. You will notice more and more flow out of the runoff. When the alcohol all but stops, check the boiler temperature. This will be the temperature at which your still will have most of the alcohol out of the brew. This is when the heat should be shut off. If the amount of alcohol coming out of the still could not keep the fire going you are putting more energy into the operation than you are getting out.

The liquid left in the boiler contains the acid you added earlier to lower the pH of your brew. This water may be cooled, the solids settled out and fed to hogs, poultry or fish and the remaining liquid put in the fermentation vat as the second half of the water to cool the brew before adding the second enzyme.

RUNOFF
There will always be some alcohol in the runoff. Although the quantity may be slight it is a good idea to rerun the runoff. It is much cleaner than the original brew and will clean out your boiler and the plumbing on the way to the columns.

CORRECTION AND ADJUSTMENTS

The first thing to be taken care of is any liquid or vapor leaks from the still. Vapor loss means loss of alcohol. This can be checked before operation by sealing off all but one opening in the still. Blow air into that opening. Any air leak would be a potential vapor leak. Seal these up. If little or no alcohol came out and the temperature in the boiler slowly rose to the boiling point of water (212 degrees F) the problem is probably not with the system, but with the fermenting. Be sure you check the runoff. There may not have been enough heat to get the alcohol to the top of the still. With too small a heat supply this could happen. The still is designed the size it is so that you can use heat sources that are normally found on the farm to power it. It can be run at minimum capacity from the burner of a gas or electric stove. This will produce 6,000 to 10,000 BTU/hour of heat.

The same problem could be caused by too great a heat loss. If you are operating the boiler outside in the winter just a little wind could cause too great a heat loss and all the alcohol could be in the runoff at a fairly high proof or could have run back into the boiler The boiler and still should both be inside a building.

TOO HIGH AN OPERATING TEMPERATURE

If, the control temperature is much above 173 degrees F when the proof of the product has peaked out (should be above 190 proof), we should make some corrections. This is caused by too much back-pressure in the boiler. Unless your pool is very deep, this would be the last thing to change. Within reason, the deeper the pool the lower the proof of the runoff. Too great a distance between the boiler and the still with too small a pipe is the most likely cause of the problem. The easiest way to maintain the low pressure required (5 lb.) and at the same time provide a blowoff valve for your boiler is to come out of the boiler with a large pipe. This pipe should be 1-1/2 to 3 inches depending on the size of the boiler. Run this pipe up and out the top of the building. Put a metal plate with a rubber ring under it on top of the pipe. Weight this cap until it weighs five pounds. A tractor exhaust rain cap with a rubber seal will work nicely. This provides a pressure release at a safe distance from workers and visitors who seem to inevitably gather around a still, and also provides some stripping action. The line to the still can be tapped off this pipe and will pick up vapors with a higher concentration of alcohol higher up the pipe.

Even inside the boiler condensation is taking place. Any piping to the still becomes a part of the distilling process. What this still is, then, is a controllable cleanup mechanism. This is why we say don't underestimate the amount it can distill. It is also why we cannot say what the hourly capacity will be until the entire system is built. The more stripping that is done before the vapors get to the still the less work the still has to do. Once we get the still to produce the proof we want the capacity can easily be increased by working with the system ahead of it. For example, we could take the water from the stripper coils and run it through coils wrapped around the big pressure release pipe between the boiler and line to the still. This water has been heated in the stripper coils to only slightly below the temperature of the vapors leaving the boiler. It would absorb a tiny bit more heat causing stripping to take place in the vertical pipe but not condensing all the vapors or cooling them to the point that the still would not work.

REMEMBER: What you want is a slowly decreasing temperature from the boiler to the condenser of the still. This is the key to the whole system. As long as you do not shock the vapor with too sudden a temperature change, the water vapor will gradually fall out, Any alcohol that may condense along with the water will have a chance to re-vaporize as it runs back to the warmer part of the still. If you understand all of the principles, you should now be able to build a distilling system with a capacity of many gallons per hour. "Start out small and grow as you get the feel of what is happening."

Can you drink it?

I get asked that question a lot! Legend, as well as lots of documented stories have it that quite a few Kentucky Moonshiners went blind from drinking moonshine. This high-proof ethanol is a long way from Kentucky moonshine.

First of all, those were very crude stills, which only condensed the vapors by running the exiting steam through a coil of copper tubing placed inside a bathtub. There was no "stripping" section, which refers to the bottom section of my still, where the hot steam first has to bubble up through some cold water. This immediately strips out a high volume of water, but in addition, it also traps the fusel oils and methanol, and other trace poisonous by-products.

If you look at the alcohol produced by this still, it should be absolutely as clear as water, and if you look at the top surface, you will not see any oils floating at the top. That is what is poisonous, and it has all been removed by virtue of the fact that this is a triple distillation process.

If you recall cartoons where they showed a moonshiner drinking out of a pottery jug with four X's (XXXX) on it, that refers to the number of times the stuff has been run back through the same still, to remove more water (increase the proof).

In case you never were told the definition of proof, 200 proof is 100% alcohol, 180 proof is 90% alcohol, etc. About the most a person can comfortably drink is 100 to 120 proof. Most whiskies are about 100 proof, and would make pretty poor fuel. Brandy might be 120 proof, or 60% alcohol, and could be used, but it would have to be a pretty warm day, or the engine already pretty hot from running previously on gasoline for it to work.

When you have a lower proof, you have to preheat the fuel to get it to ignite. You can drop a lit match into 160 proof and it will go out. When a waiter serves something with flaming brandy, they have to hold the match for a moment at the edge of the liquid, which preheats it slightly, before it will light.

Moonshiners often didn't have soft copper tubing which could be made into a coil, so they would solder short pieces together into a zig-zag assembly using lead for solder. The hot alcohol, being a rather effective solvent, would always pick up quite a lot of lead in the process, and these guys would usually die quite young of kidney failure.

I never drank my own product: I do not like, nor have I ever liked hard liquor of any kind, as it will burn it. But 160 proof is much too concentrated for anybody's tongue. The highest proof drinking alcohol I have seen on the market is 120 proof Jamaican Rum.

So, when you are making 170 or 180 proof, if someone wants to drink it, they will first have to mix it about 50/50 with water, or orange juice, or whatever, and it will still be too strong a drink.

In the USA, it is illegal to sell this stuff without first adding something that first ruins the taste and smell, and completely poisons it so it cannot be used for human consumption. This is then called denatured alcohol. It started out as grain alcohol, which is what ethanol is technically called, but ends up smelling like rubbing alcohol from the drug store because they added benzene or something equally poisonous.

When I went to Ukraine, they were very interested in buying one of my stills as they just really wanted it for making vodka. I wouldn't make one for them, as I am fairly anti-alcohol, as I have seen how it destroys minds, families, cars, and uninvolved bystanders.

However, some of the stuff I made, especially when I used grape pulp from the winery, which yielded the smell of brandy, or the beer I used from the brewery in Boulder, which made a whisky smell, has indeed looked and smelled pretty pure.
Because the alcohol is so strong, it is inadvisable to even taste it, as it immediately dehydrates whatever skin cells it touches, especially the tongue and cheeks. Alcohol this strong is hygroscopic, which means it draws moisture out of anything it contacts, even the air. So high-proof fuel must be kept sealed, or it will get diluted from the humidity in the air.

Reports from people who have built Robert Warren's still.

Hi Robert,
I ordered your blueprint for the 803 still and received it in the mail a few days later.
I am really excited about making ethanol from your still. My particular interest is using Duckweed (Lemna) which, as you probably know from your days in the central valley, is a small plant that grows on top of the water in ditches and ponds, and can theoretically be used to produce ethanol. From the literature I have been reading, it has an amazing growth rate and the growth rate can even be accelerated by adding carbon dioxide, which of course is a product of fermentation!

Duckweed also has a substantial amount of protein, and a few years back there was a project started at the U. of Wisconsin to extract protein from alfalfa which still left the fermentable sugars in the solution. This process was used to enhance the protein content of food in the diets of children in Mexico.

Duckweed has also been used by rural farmers in Vietnam and other places around the world as a feed supplement (up to 30 percent) for chickens, ducks, and other farm animals.

There are also a number of research projects using duckweed to process waste from animal barns. "Waste" from the animals is converted into "nutrients" for the duckweed, which is then composted and returned to the soil.

My eventual goal is to develop a system of growing duckweed in enclosed ponds in desert areas to provide protein, animal feed, and alcohol fuel for developing countries in semi-arid and arid regions. There was some research by a fellow in Israel who used greenhouses to return the transpired moisture from the plants back into liquid water and he was able to recycle something like 98 percent of the water in the system.

Instead of using grain from prime agricultural land, in makes sense to me to use the arid regions of the planet to produce food and fuel. With abundant sunshine, and a method to recycle water in enclosed systems, the whole project looks feasible on paper, and I am now engaged in developing a working prototype to actually demonstrate the principles in a working system. Wish me luck!

Thanks again for sharing your work on ethanol production,

Alan Davidson
Subject: RE: [biofuel] ethanol from plums

Robert,
Thanks, you are a big help! Thanks to you I will be soon making my own fuel for my farm. I can get lots of rotten peaches and plums in season.
One more thing. Will it be better to use just the
juice?

Dear Van,
Yes, I have made ethanol from plums and also from peaches. The key to doing it without adding sugar is to use overripe fruit, or windfall fruit. Good fruit which has a commercial food value would

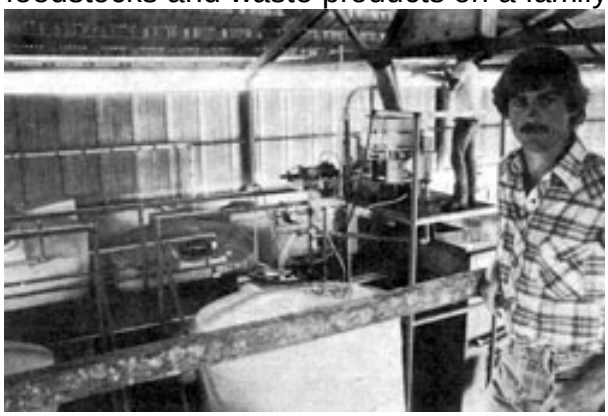
not be economical to turn into fuel: it will cost a high price as produce.

The only real problem is the issue of dealing with the stones. What I did, was to fill a 50-gallon barrel about 2/3 full with the overripe fruit, and then add water until it was about at a little over half full of water (more fruit than water). Then add a 1/4 pound of baking yeast from the natural food store. (I don't know what this is by volume, but I expect it is about one part water to three parts fruit). Then I took a garden hoe and mashed and hacked at the fruit for about a half hour each time, three or four times a day, for the first three or four days (outside temperature makes a huge difference in how quickly the yeast takes hold and reproduces.) You can let it ferment for maybe a week, but keep the fruit flies away with some cheesecloth, or they will contaminate the batch and it will turn to vinegar.

The next step makes it a bit easier to handle your mash. I used a 1/4 inch wire mesh screen to strain out the stones, fastened to the top of the barrel with some bailing wire. I scooped out the gooey mash with a plastic bucket and dumped it into my cooker barrel with the wire mesh tied securely around the top of the barrel. (Use enough stiff wire screen so that you have a pretty good depression in the middle, so that as you pour, it doesn't run off to the outside of the barrel). This way you are also filtering out some of the skins, which can be thrown into the compost. If you filter it too fine, you lose lots of good sugary pulp. Test your fermented mash with a sugar hydrometer before running it through your still, as you want to make sure it is fully fermented. Here is a link to buying hydrometers.

Floyd Butterfield's still

The Floyd Butterfield project was in response to a $50,000 prize offered in 1980 by the Calif. Dept of Agriculture. The intention of the contest was to encourage farmers to make their own fuel. Mr. Butterfield won over many other farm stills built during this contest, because of its efficiency and overall integration of the entire process of using feedstocks and waste products on a family farm.



Floyd Butterfield material is a true ethanol fuel pioneer, and he built and ran quite a decent traditional still with a lot of heat-recovery improvements.

Introduction

This report provides details concerning the design, construction, operation and performance of the FSB Energy Fuel Alcohol Plant. The report was compiled in response to the announcement by the California Department of Food and Agriculture and the State Solid Waste Management Board of their joint sponsorship of the Alcohol Fuel Plant Design Competition.

The FSB Energy Fuel Alcohol Plant is located on a ranch approximately six miles north of Paso Robles, California. It presently is operated by one man on an approximately eight hour per day test basis. The plant-currently processes off-market barley and wheat. The processed grain co-product of the plant is being sold to local dairy operators as a high protein component in the milk cow ration. The ethanol product is being tested and evaluated as an alternate motor fuel by several local vehicle fleet operators. Production of 10 gallons per hour of 190 proof alcohol, on a regular 24 hour per day schedule is anticipated by July 1, 1981 or sooner.

Background

In May, 1980, Floyd Butterfield of Paso Robles, California and Stuart Gildred of Santa Ynez, California formed a partnership to construct a small and efficient fuel alcohol plant. The purposes of building the plant were to promote awareness of an alternate, renewable fuel, to manufacture and sell the fuel, and to gain the expertise needed to manufacture and sell low cost and efficient fuel alcohol plants in the future.

Design of the existing plant began in March, 1980, and construction was initiated in June of that year. Almost all components of the plant were either built at the on-site shop or purchased as off-the-shelf items. The sieve plates e£ the distillation columns were custom-made to specifications by a local sheet-metal shop.

The performance of the distillation columns and associated equipment was tested in October and November of 1980. Subsequent to this successful testing, further equipment was designed, and built or purchased, to allow semi-automatic continuous production at the plant.

Operation resumed in April, 1981 with the plant most recently producing approximately 12 gallons per hour of 180 proof ethanol on an eight hour per day test basis.

Preliminary Design Specifications

Front-End Handling Equipment

Front-end handling involves preparation of the feedstock for processing. This preparation consists of reducing the feedstock particle size to render it susceptible to enzyme breakdown and efficient mixing during cooking. In selecting a specific grinding technique one must also consider the end use of the cooked feedstock and the solid/liquid separating method used later in the

For most grain feedstocks we prefer the use of a roller mill. A roller mill produces uniformly reduced grain with a low percentage of fines. Roller mills also use significantly less energy than most other types of grinders. A roller mill with a minimum capacity of 3000 to 6000 lbs. per hour should be employed. Much of the feedstocks are obtained already ground.

If the feedstock contains larger foreign material (such as dirt clods and small rocks) then it cannot be processed by a roller mill without first being crudely sorted. This sorting can be accomplished by a "scalper".

An alternative to a roller mill is a hammer mill. It can successfully grind a wide variety of feedstocks and can directly process feedstocks containing some foreign materials. Feedstocks should be ground by a hammer mill to pass a 1/8 to 3/l6 inch mesh screen.

Following particle-size-reduction, the feedstock is augered into the feedstock storage tank shown on Plate 1. From there it is augered onto a scale, weighed and augered into the cook tank. The augers shown on Plate 1 are four inches in diameter and powered by 1 hp. electric motors. The scale is of the type used to weigh bagged almonds, walnuts, etc. and has a 1000 pound capacity. Any type of scale with a capacity of several hundred to several thousand pounds may be used.

Handling of other than grain feedstocks requires the use of appropriate methods for particle-size reduction, transfer and weighing.

Cooker

The cooker is a 3000 gallon mild-steel tank typically used for underground fuel storage. It is positioned on two steel support pillars and tilted toward the outlet at an approximately 10° angle [Plate 1]. The tank i s equipped internally with a 1-1/4 inch diameter perforated steam line for direct injection of steam and a paddle-type mixer. The mixer consists of four paddles mounted on a two-inch diameter shaft which passes longitudinally through the cooker. The mixer is powered by a l-1/2 hp. motor/gear reducer combination coupled by chain drive to the mixer shaft. The outlet from the cooker is via a two-inch valve and hose connection.

Solid-Liquid Separator

The separator is used to separate the solids from the liquid portion of the mash prior to fermentation or distillation. It consists of a nine-inch diameter double flighted auger positioned horizontally within a 9-1/4 inch diameter perforated sheet-metal tube. The auger is mounted on a two-inch diameter steel shaft which is turned by a hp. electric motor/gear reducer combination.

Whole mash is pumped into a hopper at one end of the auger tube. As the mash is augered along the tube, the liquids fall through the perforations, are collected in a basin, and directed to a two-inch hose outlet. The solids continue along the tube, are pressed in a short, augerless section at the end of the tube and then discharge and fall by gravity into a truck.

The liquids discharge out of the separator and may be directed either to a tube-in-tube heat exchanger or directly to a tank via hose connections.

Fermentation Section

Each fermenter consists of a 1300 gallon plastic tank, the type typically used for above-ground water storage.

Each tank is positioned on a stand made of two-inch diameter steel pipe and tilted toward the outlet at an approximately 7° angle. Each fermenter is equipped with a thermometer.

Discharge is through a two-inch hose connection via a two-inch ball valve.

Distillation Section

During distillation, fermented and filtered mash or "beer" is pumped continuously from the beer well by a 1/6 hp. centrifugal pump. Flow is regulated by a globe valve and monitored by a flow meter. The beer proceeds to the inlet of Heat Exchanger 2 as shown on Plate 2. This is a single-pass, tube-in-shell heat exchanger available as an off-the-shelf item from several manufacturers. From the outlet of Heat Exchanger 2, the beer proceeds to the inlet of Heat Exchanger 1. This is a two-pass tube-in-shell heat exchanger, also available from several manufacturers. From the outlet of Heat Exchanger 1, the beer is fed directly to the inlet of Column 1.

Column 1 is illustrated on Plate 2. Its shell is an eight-inch diameter mild steel pipe and the internals are all mild steel. The beer feed is injected into the downcomer of the second highest plate in the column. The feed falls down the downcomer and impinges on a blank portion of the plate below (see illustration of sieve plates on Plate 2). It then travels across the perforated portion of that plate, over the outlet weir, and down the downcomer. After traveling down the entire length of the column and across each sieve plate the resulting "bottoms" product or "stillage" is pumped through Heat Exchanger 1 and to the stillage holding tank (Plate 1). The pump at the base of column 1 is a 1/6 hp. centrifugal type.

The purpose of Column 1 is to "strip" all the alcohol out of the feed. Low

pressure steam is injected into the base of the column and rises through the plate perforations. The steam carries with it the alcohol in the feed and some water. Alcohol vapor at approximately 100 proof leaves the top of Column 1.

The alcohol vapors from the top of Column 1 proceed through the exhaust tubing shown on Plate 2 and enter the base of Column 2. These vapors rise through the perforations in the plates of Column 2 and exit at the top of the column. The vapors are then partially condensed by the beer feed passing through Heat Exchanger 2. Next, they pass through the air-cooled heat exchanger shown on Plate 2 (a truck radiator in this case) where they are completely condensed and sub-cooled. The sub-cooled product flows by gravity to the reflux drum where a portion of it is pumped back to the top of Column 2.

The reflux pump is a centrifugal type, powered by a 1/3 hp, single phase, explosion-proof electric motor. The reflux flow rate is controlled by a temperature-regulated valve whose sensor is placed in the top of Column 2; the rate is monitored by a flowmeter.

The portion of product that is not returned to Column 2 as reflux flows out the overflow of the reflux drum (Plate 2) and through Heat Exchanger 3, a single-pass tube-in-shell type (available off-the-shelf). Cool water flows through this heat exchanger at approximately 1 to 2 gallons per minute and comprises almost the entire process water consumption of the plant. It is directed from this exchanger to a holding tank for use in the cooker or to the steam boiler. Heat Exchanger 3 also serves as the vent passageway and thus cools any gases or vapors vented by the system. The final ethanol product flows by gravity to a 300 gallon plastic holding tank.

Heat Source Unit

Heat in the form of steam is supplied to the cooker and distillation section. A 10 hp. propane-fired steam boiler is presently being utilized. Any source which provides an equivalent quantity of heat at approximately 212℉ or greater may be employed. When the heat is not in the form of steam, a heat exchanger at the base of Column 1 can be used and intank pipes or another method of providing heat to the cooker must be utilized.

Product and Co-product Storage

The ethanol production from each 24-hour period i5 accumulated in the 300 gallon plastic holding tank. It is then checked for proof, denatured and transferred by gravity to bulk storage, an underground steel fuel storage tank.

The wet grain co-product discharged by the separator is accumulated in a truck and fed daily to dairy cattle. There is no co-product storage.

Waste Disposal

A portion of the stillage from the bottom of Column 1 is the only waste product of the plant. The stillage consists of hot water containing dissolved and suspended solids not removed by the separator.

At present, approximately 25 to 40% of the hot stillage is reused in the cooker. This accomplishes a substantial savings in process water consumption and in BTU's since each cook begins with preheated water.

The portion of the stillage that is not recycled is directed to a holding tank (Plate 1) via another single-pass heat exchanger which preheats the boiler feedwater. Presently, this remaining stillage is periodically discharged to an outside holding pond where it is allowed to percolate and evaporate.

Preliminary Performance Data

Capacity Alcohol Production

The plant is designed to operate 24 hours per day at 10 gallons of 190 proof ethanol per hour. Based on operation six days per week, annual production would be 70,000 to 75,000 gallons.

Quality of Alcohol

Design quality is 190 proof at 10 gallons per hour. Proof can be diminished somewhat by decreasing the amount of reflux, giving a corresponding increase in final product rate.

Energy Inputs

There are two types of energy input to the production process, electricity and boiler fuel in the form of propane. The following two tables illustrate the use of these energy sources on a kilowatt hour per gallon (KWH/gal) and BTU per gallon (BTU/gal) basis.

Table 1: Plant Electricity Use (1)

Use	Motors		Daily Use	KWH/Day	KWH/Gal
	HP	Watts	(hrs.)		
Cook tank mixer	1-1/2	1800	9	16.2	
Separator	1/2	1000	6	6.0	
Utility pump	3/4	1200	7	8.4	
Distillation					

Beer pump	1/6	400	24	9.6	
Bottoms 1 pump	1/6	400	24	9.6	
Bottoms 2 pump	1/3 (2)	750	24	18.0	
Reflux pump	1/3 (2)	750	24	18.0	
Condenser fan	1/12	200	24	4.8	
Compressor (controls)	1	1400	8	11.2	
Utilities (3)				20.4	
Subtotal for Distillation				71.2	0.297
Plant Total				**122.2**	**0.510**

Table 2: Plant Boiler Use (1)

Use	BTU/hour	Daily Use (hrs)	BTU/day	BTU/gal.
Cooker	135,000	8.2	1,100,000	4,600
Distillation	120,000	24.0	2,880,000	12,000
Plant Total			**3,980,000**	**16,600**

(1) based on 24 hours per day production at 10 gallons per hour

(2) both considerably oversized since 1/3hp was the smallest explosion proof motor we could find at the time

(3) lights, boiler controls, water softener, etc., estimated at 20% of plant total.

The external energy requirements of the plant are presently being met by conventional energy sources. Electricity is supplied by the local utility and the boiler fuel being used is propane. Examination of Tables 1 and 2 and use of a conversion factor of 1 KWH = 3413 BTU reveals that approximately 10.5% of the plant's energy use is electrical and 89.5% is provided by the steam boiler.

Any number of devices that provide the needed electrical and heat energy from-renewable sources may be utilized. The only requirements are that the electricity provided must be compatible with the needs of the electrical

equipment used and the heat source must be capable of providing the required number of BTU's at approximately 212 deg F or greater.

Useable Feedstocks

By carrying out the solid-liquid separation process before fermentation, the processing of all feedstocks is nearly identical from after separation through distillation. The front-end-handling, cooking, mixing and separating equipment of this plant have been designed and used for processing various grain feedstocks. The use of any non-grain sugar or starch feedstock would simply involve modification or replacement of some of this apparatus with appropriate equipment.

Conclusions

The FSB Energy Fuel Alcohol Plant operates at a remarkably high energy efficiency and yields consistent, high quality products. Extensive use of heat recapture and efficient plant layout allow minimum consumption of external energy inputs.

One man presently operates and maintains the plant and equipment. Several grain feedstocks have already been processed and the plant is adaptable to processing a wide variety of materials.

Almost all major components were either built in the on-site shop (a typical farm-equipped shop) or purchased as off-the-shelf items. Materials of construction are primarily mild steel, but all fermenters and holding tanks are plastic. With the exception of the distillation column internals, projected equipment life is a minimum of ten years during which only routine maintenance will be required. The useful life of the column internals, constructed of mild steel, is presently unknown. These internals could be easily constructed of stainless steel should it be necessary.

The total investment in the equipment at the plant is approximately $40,000. This figure is based on purchase of new, off-the-shelf items and could be reduced by employing used equipment where possible.

In summary, we believe the FSB Energy Fuel Alcohol Plant is one of the most low-cost and energy efficient, continuous production fuel alcohol plants available. It can provide the owner/operator with a consistent product yield for direct use or sale. By processing off-market grains or waste products, the plant can show a substantial operating profit.

Getting a permit in the USA

How difficult/expensive is the US licensing process for making alcohol?

A. Getting a license from the Bureau of Alcohol, Tobacco, and Firearms (**BATF)** is not difficult, and only takes about a month.
Click the blue link at the top of this page to see the 5 pages of forms and instructions for the "fuel distillers' permit". Be sure to check the box showing that you will produce less than 10,000 gallons per year, or you will have to post a bond.

Take a look at this new web site from the BATF (Bureau of Alcohol, Tobacco, and Firearms) for kids. It tells you how to get the permit.

I thought it pretty strange that the BATF would have a web page for kids, but it is even stranger that this site for kids is labeled, "Bureau of Alcohol, Tobacco, Firearms and Explosives". Check it out: http://www.atf.treas.gov/kids/faq.htm

Application form 5110.74 and additional information are available from the: Bureau of Alcohol, Tobacco and Firearms,
National Revenue Center, Spirits Unit A,
550 Main Street, Room 8002,
Cincinnati, OH 45202-3263
1-800-398-2282 or (513) 684-7150
natlrevctr@cinc.atf.treas.gov

Alcohol Fuel Credit

If you sell or use alcohol as a fuel, you may be eligible for an income tax credit. The alcohol fuel credit consists of a straight alcohol credit, an alcohol mixture credit, and a small ethanol producer credit. Each of these credits is discussed later.

Small Ethanol Producer Tax Credit

The small ethanol producer tax credit is an incentive enacted by Congress in 1990 to promote greater participation in ethanol production – so that farmers and other small business interests could compete with larger, more wealthy investors to produce ethanol.

Under present law, small ethanol facilities are provided a production income tax credit of 10 cents per gallon on up to 15 million gallons of

ethanol per year. Current law defines a “small ethanol producer” as one whose production does not exceed 15 million gallons annually and whose production capacity does not exceed 30 million gallons annually.

Alcohol eligible for the credit includes methanol and ethanol. This includes methanol produced from methane gas formed in waste disposal sites. But it does not include any of the following.

- Alcohol produced from petroleum, natural gas, or coal (including peat).
- Alcohol with a proof of less than 150.
- Ethanol produced as a by-product from manufacturing ethylcellulose derived from ethane.

In figuring the proof of any alcohol, disregard any denaturants (additives that make the alcohol unfit for human consumption).

Straight alcohol credit. You can claim the credit for any alcohol not mixed with gasoline or a special fuel other than denaturants.

You are eligible for the credit for straight alcohol only if you met one of the following requirements during the tax year.

- You used it as a fuel in your trade or business.
- You sold it at retail and placed it in the fuel tank of the buyer's vehicle.

The buyer cannot claim the credit for the alcohol bought at retail, even if the buyer uses it as a fuel in a trade or business.

Mixing or failure to use as fuel. If the credit applied to alcohol you bought and you later mix the alcohol or do not use it as a fuel, you must pay a tax equal to the credit. Report this tax on Form 720.

Table 4-1. How To Figure the Straight

Alcohol and Alcohol Mixture Credits

IF the alcohol is...	AND it is...	THEN the credit for each gallon is...
At least 190 proof	Alcohol (other than ethanol) Ethanol	$.60 $.53
At least 150 proof but less than 190 proof	Alcohol (other than ethanol) Ethanol	$.45 $.3926

ATF, Alcohol Fuels, and the Crude Oil Windfall Profit Tax Act of 1980

The U.S. Department of the Treasury, 22 years ago, published regulations establishing a new category of distilled spirits plants for producers of alcohol exclusively for fuel. The Energy Tax Act of 1980 instructed the Department of Treasury to encourage and promote alcohol fuel production.

In May 1979, the US Treasury, in conjunction with BATF, proposed legislation to Congress to facilitate alcohol fuel production. With minor changes Congress added this proposal to the Crude Oil Windfall Profit Tax Act of 1980 (Public Law 96-223). The Act granted the Secretary the authority to waive provisions of law relating to distilled spirits. The pertinent portions of the Act become effective July 1, 1980.

Key components of these regulations

BATF will substantially reduce the regulatory burden faced by alcohol fuel producers. The new regulations, effective July 1, establish a regulatory systems which divides alcohol fuel producers into three categories.

Small:
Produces and receives not more than 10,000 proof gallons of alcohol per year.

Medium:
Produces and receives more than 10,000 but not more than 500,000 proof gallons of alcohol per year.

Large:
Produces and receives more than 500,000 proof gallons of alcohol per year.

The new regulations include the following major provisions.

Application procedures are reduced.

Small plants will file only a single simplified ATF form giving basic information about the operation. Medium and large plants must supplement their application with additional information. The documents required, however, are less than 25% of what is required for beverage alcohol plants. Interested persons may obtain an application form from only one ATF regional office at:

ATF

Technical Services

550 Main Street, Room 6525

Cincinattit, OH, 45202

513-684-3354

Ask for ATF Form 5110.74. The AFT permit is limited by law to plants which produce alcohol exclusively for fuel use. The permittee must produce alcohol to be eligible for a permit. Alcohol produced under this new law may be used only as a fuel.

Applications will be promptly processed.

ATF will determine the eligibility of the applicant for the permit within 60 days of the receipt of the completed application by ATF.

Bonds are significantly reduced.

Small plants are not required to file a bond. Medium and large plants are required to give bonds (generally obtained from insurance companies for nominal annual premiums). ATF substantially reduced bond amounts by up to 80% from previous requirements for alcohol fuel production.

Denaturation requirements are liberalized.

In order to render alcohol unfit for beverage use, AFT's will have greater flexibility in comparison to requirements for denatured alcohol. ATF has reduced the amount of denaturant required and increased the number of acceptable denaturants.

Record and report requirements are reduced or eliminated.

Producers may record transactions on commercial records. ATF does not require any special forms for maintaining records and has reduced substantially the frequency of reporting.

Alcohol may be used as fuel on the premises of the AFP.
An AFP may use alcohol for fuel on the premises of the plant without rendering the alcohol unfit for beverage use.

Background.
The law previously hindered alcohol fuel production. Although existing

requirements were well suited to regulating beverage and industrial alcohol, they inhibited the production of alcohol fuel. In order to facilitate alcohol fuel production, ATF provided all lawful administrative relief possible prior to passage of Public Law 96-223. For example, ATF reduced the bond requirement for experimental permit holders, and liberalized denaturant formulas. These efforts, however, were insufficient for a long term program of alcohol fuel development. P.L. 96-223 authorized the Secretary of the Treasury to waive those provisions inhibiting alcohol fuel development.

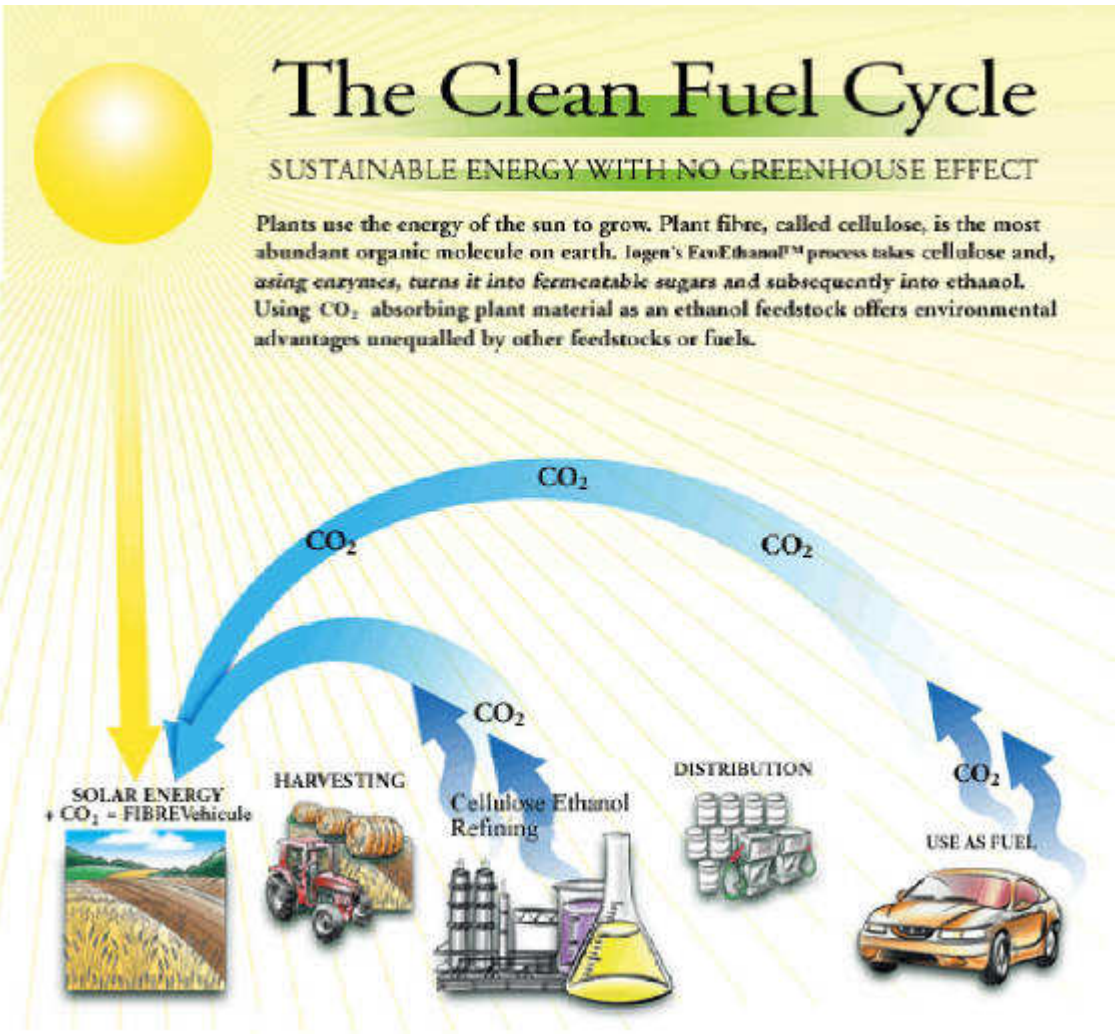
Commercial Alcohols Inc.



Fuel Ethanol and Industrial Alcohols Production

A typical 40 million gallon per year ethanol production facility using dry corn.

Making fuel out of Rice Straw, Wheat straw & Corn stalks



Natural cycle chart courtesy of Iogen.

Huge breakthrough--or, huge mistake?

The ability to make ethanol from straw-- rice straw, wheat straw, oat straw, etc—is the modern day equivalent of the Holy Grail or the Philosopher's Stone. In a time when barely any new oil fields have been discovered in the past ten year-- and a war in Iraq rages with such anarchistic abandon that it seems unlikely that anyone will be able to pump oil for a the next several years—well, the news that we can run our cars on this "new" fuel is a breathe of fresh air. Literally! Ethanol burns much cleaner than gasoline, and doesn't add fossilized CO2 to the atmosphere: it is recycling present day CO2.

However, this new development does have Greenpeace and other environmental activists worried: It involves a genetically modified organism: a genetically engineered yeast to convert glucose AND xylose into ethanol.

They added three genes to plain old Saccharomyces yeast so that it can break down both sugars at the same time.

They claim a 30~40% increase in yield. This could be a huge breakthrough--or a huge mistake. Xylose makes up roughly 30~40% of celluloid materials like corn stalks, grass, wood chips, leaves, etc. In short, a yeast that feeds on xylose can feed on almost anything in the plant kingdom.

Intensive research on cellulose conversion to ethanol previously focused on mechanical, heat and acid hydrolysis techniques, all of which are expensive. Propagating a yeast organism, on the other hand, seems as simple as baking bread or brewing beer.

But don't expect that we small scale distillers will be able to buy this anytime soon.

It's the property of Purdue University & they have taken a completely novel approach to marketing this patented technology. They are "leasing" (not selling) the yeast to a Canadian company, Iogen.

http://www.Iogen.ca

Logen is already producing ethanol and selling it to Petro-Canada for mixing with gas. They are claiming 75 Gallons per ton of straw, with roughly 2/3 of the straw being converted.

It is interesting that Iogen and Shell chose to announce this product to the world in Europe, which historically has been actively fighting any GMO products. Just a week later in Madison, Wisconsin, the 20th annual Fuel Ethanol Workshop had over 1500 ethanol industry attendees, including Iogen-- an exhibiting company, but no mention of this breakthrough was mentioned.

Apparently, Iogen, Shell, and Petro-Canada are playing their cards close to their vests. The market for fuel ethanol is established beyond any doubt: it is presently a 3 billion dollar/year industry. By keeping this technology to themselves, a new bio-technology industry promises to be the new Middle East in terms of fuel supply.

The other corporate players in this announcement, DaimlerChrysler and VW, have long produced cars that will run or 85% to 100% alcohol--previously only in Brazil, but now in the US, too.

A report titled "Genetic Engineering,Too good to go wrong?" can be found at:

http://archive.greenpeace.org/comms/97/geneng/getoogoo.html

This above link lists various accidents and very dangerous and toxic side effects of genetic engineering efforts so far. An unrelated but somewhat parallel effort to produce a GMO yeast produced very high toxic levels of a mutagenic product, methyl glyoxal, with the potentially undesirable effect of getting loose into the food chain.

Big business stands to make billions on GMO products, especially one such as a new organism that can readily turn straw into fuel. The Iogen press release, below notes that collaborated with Shell and Petro-Canada.

It seems the real credit goes to Dr. Nancy Ho, a Purdue scientist who made her breakthrough in 1993. No mention was made of her or Purdue University in any of the Iogen or Shell press releases.

In terms of agriculture, if GMO organisms can be contained within the capital intensive

manufacturing facilities (where trucks hauling rice and wheat straw will come and go every day) this means that farmers will no longer burn their rice straw. This will have an additional effect of containing CO2—nobody likes the smoke from huge field burns. But on the other hand, if these trucks end up picking up some "hitch-hiker" organisms on their rounds, the possibility of a GMO yeast that dissolves xylose, if it gets out into the environment, sounds like a script from a science fiction thriller.

CELLULOSE ETHANOL IS READY TO GO

Iogen producing world's first cellulose ethanol fuel

Ottawa – Iogen Corporation announced today that it is producing the world's first cellulose ethanol fuel for commercial use. Cellulose ethanol is an ultra-low CO2 emission fuel that can be blended with gasoline and used in cars today.

"Today marks the first concrete signal of a major change coming in the fuel market," said Iogen President, Brian Foody. "We have always looked to better and more efficient vehicles to reduce fossil fuel consumption. Now, new advanced fuels are ready to play a role too!"

"Canada is on the cusp of a new energy era and companies such as Iogen are showing the way," said the Honourable Paul Martin, Prime Minister of Canada. "Our technological expertise in clean energy will be one of the pillars of our economic and environmental prosperity in years to come."

"This milestone would not have been possible without the commitment, support and vision of Shell, Petro-Canada, and the Government of Canada," said Foody. "These organizations have shown that they are committed to bringing forward technologies that really can make a difference."

Iogen's cellulose ethanol technology is a result of more than 25 years of research and development. Iogen and its partners have committed over C$110 million, and the company owns and operates the world's only cellulose ethanol demonstration scale facility.

"Iogen has demonstrated that clean, renewable fuels are no longer a dream, they are a reality," said Duncan Macleod, Portfolio Manager of Shell Global Solutions International B.V. "We believe that the global market for bio-fuels such as cellulose ethanol will grow to exceed $10 billion by 2012. Cellulose ethanol is a great fit with Shell's commitment to leadership in fuels technology and sustainable development."

"All of us at Petro-Canada are pleased to see Iogen bringing its leading-edge cellulose ethanol technology to fruition," said Petro-Canada Vice-President Andrew Stephens. "We made our first investment in this technology over five years ago, so it's fitting that Petro-Canada will be the first user of cellulose ethanol, and will be receiving the first shipment at our Montreal refinery."

"GM Canada welcomes Iogen's introduction of cellulose ethanol as a very significant product development that could make a considerable contribution to the reduction of greenhouse gas emissions," said David Paterson, Vice-President, General Motors of Canada. "GM's entire portfolio of vehicles is already capable of running on a blend of 10 per cent ethanol. We are pleased to see a leading-edge Canadian company like Iogen develop the next generation of ethanol and we encourage its adoption in the marketplace."

"All vehicles can use a standard blend of up to 10 per cent cellulose ethanol mixed with gasoline, with no changes required.

"Iogen's cellulose ethanol demonstration facility is the final proving stage prior to the rollout of full-scale commercial plants. The company is working with its partners to finalize plant locations.

"Cellulose ethanol has two unique advantages over conventional ethanol. First, the greenhouse gas emission reductions from cellulose ethanol are three times greater than those from grain based ethanol on a life cycle basis. Second, cellulose ethanol is made from a plentiful and renewable resource, the non-food portion of agriculture crops (e.g. straw, corn stalks and corn cobs)."

See related article on Iogen, Shell, & Daimler Chrysler. Click here.

DEO Funds Research

According to Business Week, Dr. Nancy Ho and Purdue aren't the only players in that lucrative bioethanol arena.

"The race to create new microbes capable of fermenting the full range of sugars found in biomass has followed several successful pathways. Dr. Lonnie Ingram at the University of Florida started with an E. coli bacterium capable of metabolizing multiple sugars and added the ability to make ethanol-a feat for which he received U.S. Patent #5,000,000 in 1990. His work was sponsored by the Biofuels Program and others.

Taking an approach that complements Dr. Ingram's E. coli, other DOE researchers started with the bacterium Zymomonas, a naturally efficient ethanol-producing bacterium, and added the capability for utilizing multiple sugars. (see "Zymomonas recognized by scientific peers,").

DOE also helped support Purdue's Dr. Nancy Ho, who started with the "industrial workhorse" for ethanol production-the yeast Saccharomyces-and added the capability for utilizing multiple sugars.
All three organisms are now being tested by industrial partners for use in bioethanol production."

Fuel vs. Food

Take a look at this page for the Canadian Renewable Fuels Association.

http://www.greenfuels.org/ethafood.html

First of all, you get 2 to 4 times more energy from alcohol fuel than the energy it takes to produce it. But the main thing in terms of fuel vs. food is that fermenting grains and then distilling out the ethanol leaves you with a higher protein feedstock than the original grain itself: it is easier for milk cows to digest it, and the extra protein comes from the fact that nutritional yeast organisms were grown. It is sold as Distillers Dried Grains (DDG) and gets a higher price per kilo than raw grain, so this makes economic sense, too.

Have you ever bought nutritional yeast in a health food store and sprinkled it on a salad or on popcorn? It is delicious! English folks love their Marmite spread on toast: another yeast product from the brewing industry. This is an acquired taste, perhaps, but it is high in B vitamins.

This group, Food First, points out in their work, The Myth of Scarcity that there is more than enough grain to feed the worlds 5 billion people. It is usually the problems of war, of dictators, and of the insanities of Globalism which makes people grow cash crops instead of food crops they could use locally, creating the horrible shortages creating malnutrition and starvation.

12 Myths About Hunger

http://www.foodfirst.org/pubs/backgrdrs/1998/s98v5n3.html

Also, a lot of corn goes unused and could be made into ethanol instead of rotting. See:
http://www.news.wisc.edu/view.html?get=6810

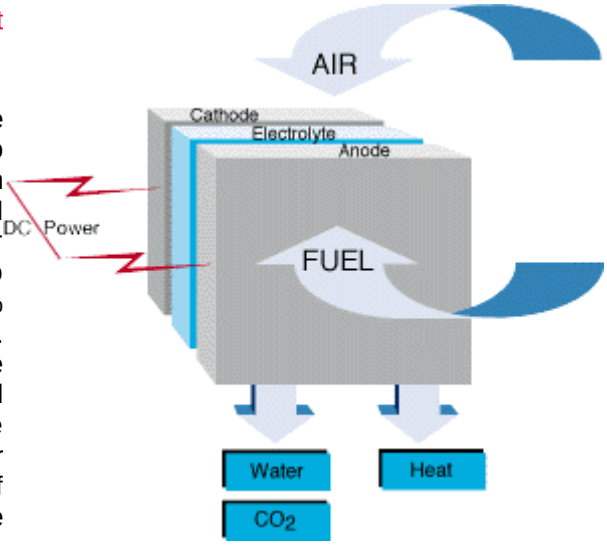
ETHANOL VS HYDROGEN

Ethanol is a lot less expensive than Hydrogen.

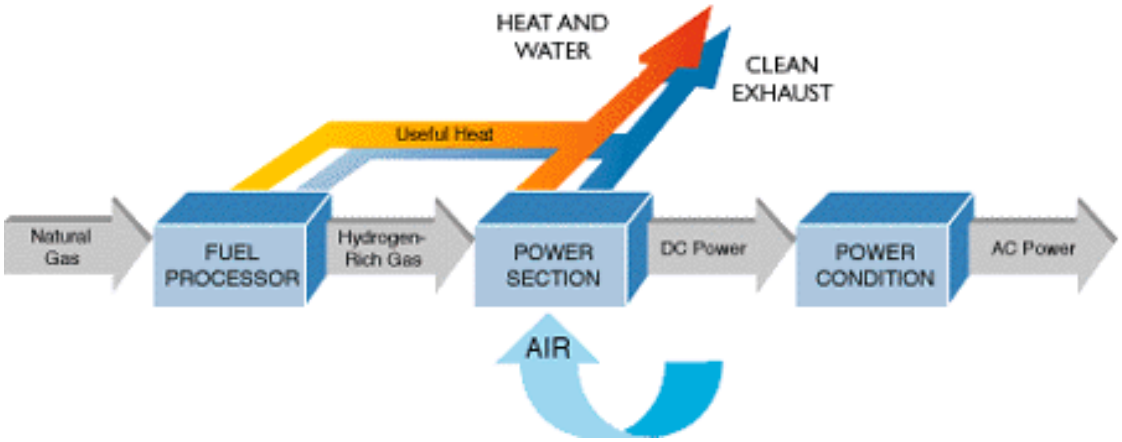


Using ethanol to make hydrogen for a fuel cell, you would get 60% efficiency

Ethanol is the perfect fuel for Fuel Cells



A fuel cell is a device that can obtain 40 to 50% efficiency in conversion of a fuel into useable power (as opposed to approximately 18% efficiency for the average internal combustion engine). This technology is a by-product of the NASA space program, developed to provide a lightweight and efficient power source for use on manned space missions. Some fuel cells use specialized molecular sieves made of complex polymers with some type of anode/cathode properties, and others use expensive platinum catalysts. There are four main types available. Some use pure hydrogen as a fuel source to make electricity. Some are designed to run on propane, but may only have a membrane life expectancy of 3,000 hours (125 days). One of the main problems with any fuel cell is contamination of the membrane. So it seems like a great advantage, then, to use a fuel source which has been distilled and is 99.9999 % pure. The ideal fuel for a fuel cell is ethanol. Plus, this is a biologically derived fuel with no horrible byproducts.



The ideal fuel cell would use ethanol instead of natural gas
Ethanol Research notes:

Over the past several years, Arthur D. Little, with support from the Illinois Corn Marketing Board and other organizations, has developed a fuel processor that allows fuel cell powerplants to operate on ethanol. Ethanol used in transportation applications reduces oil dependence and results in lower emissions. Fuel cell applications are particularly desirable for ethanol because:

1. Fuel cells operate very efficiently compared with internal combustion engines, reducing the price gap

between utilization of ethanol and cheap imported gasoline.

2. Hydrated ethanol (alcohol which still has some water content, not 200 proof) can be used in a fuel cell system with no loss in efficiency compared with 100 % high-grade ethanol, opening the way for the use of ethanol that can be used at a lower cost.

In a program conducted in 1996 for the ICMB, Arthur D. Little conducted a series of tests to demonstrate the use of hydrated ethanol in an advanced fuel processor. The results of this testing were successful and have been presented at prominent industry gatherings, including the 1996 Fuel Cell Seminar and the 1996 DOE Customer Coordination Meeting. This research is also the subject of a paper entitled, "Evaluation of Hydrated Ethanol in an Advanced Fuel Processor," which has already been accepted for publication and will be presented at The Society of Automotive Engineers Annual Conference in March, 1997. This technical work and publication effort has kept ethanol positioned as a desirable fuel cell vehicle fuel. In the meanwhile, fuel cell vehicle advancements have occurred in other programs at a very rapid pace.

The proposed program for 1997-2000 will continue to promote the use of ethanol in advanced fuel cell powerplants. Arthur D. Little will compete on a team for a $15 million, three-year, cost-shared DOE contract to develop a fuel cell powerplant capable of operating on multiple fuels. In Arthur D. Little's proposed program, ethanol has a visible and attractive role. The designs and tests conducted in this program will highlight ethanol's performance in a 50-kW fuel cell powerplant. By 2000, this powerplant--capable of operating on both ethanol and ethanol blends--will be ready for integration into a prototype light-duty vehicle or hybrid bus. This program thus positions ethanol as a premier fuel for transportation powerplants of the 21st century.

IMPACT STATEMENT:

This program will demonstrate that ethanol--even low-cost hydrated ethanol--can be used in advanced fuel cell vehicles. Fuel cell buses operating on other fuels are already on the road. Under the Partnership for a New Generation of Vehicles, each of the Big Three is working on fuel cell passenger cars. By 2008, a fleet of 3,000 fuel cell buses and 5,000 fuel cell cars could consume about 18 million gallons of ethanol yearly.

Illinois Corn Marketing Board:

Breakthrough research sponsored by the Illinois Corn Marketing Board and the State of Illinois has opened the way for efficient, zero-pollution fuel cell cars and buses powered by ethanol. Fuel cells are up to three times as efficient as conventional vehicles and emit virtually no pollutants. Renewable ethanol made from corn can power these fuel cell vehicles using an ethanol fuel processor developed by Arthur D. Little, Inc., of Cambridge, MA. Ethanol is the ideal fuel for advanced fuel cell vehicles since it reduces oil imports and has fewer negative consequences for the environment than any other practical fuel alternative.

Background

In 1996, several stunning achievements in fuel cell vehicle technology were announced by major automakers. In May, Daimler-Benz unveiled its NeCar II, a second generation fuel cell powered van with a 200-mile range and five-passenger capacity. In October, Toyota showed a fuel cell vehicle based on the highly popular RAV4, a sport utility vehicle. Both companies have announced satisfaction with the progress of fuel cell technology, and both have publicly stated their intent to proceed toward a production decision for fuel cell vehicles. These vehicles are shown in Figure 1. *Automotive News,* the most authoritative (and technologically conservative) source in the industry, covered these developments with front page stories. Discussion in the automotive industry has turned from debate over the practicality of fuel cell vehicles toward a discussion of possible timetables for their introduction.

While the practicability of fuel cell technology has been demonstrated, the issue of which fuel these vehicles will operate on is still very much in flux. Fuel cells ultimately need hydrogen to operate. The Daimler and Toyota vehicles operate directly on hydrogen, which is an impractical transportation fuel for the near term. Daimler, Toyota, General Motors, and Georgetown University all have major programs underway to develop fuel cell powerplants that utilize methanol. The American Methanol Institute is a vocal advocate of methanol as a future fuel. Methanol is not a logical or appropriate fuel since no production or delivery infrastructure currently exists, and its use will not reduce dependence on foreign energy resources. In addition, methanol fuel cell vehicles cannot utilize ethanol.

Over the last several years, Arthur D. Little, with support from the Illinois Corn Marketing Board, the State of Illinois, and the Department of Energy, has worked to keep ethanol positioned as a viable fuel for fuel cell vehicles. In 1994/1995, this involved critical technology demonstrations and design developments that proved that ethanol can be effectively transformed into hydrogen on board a fuel cell vehicle. Figure 2 shows the resulting 50 kW multi-fuel reformer on its test stand. This fuel processor is more advanced and compact than any methanol fuel processor shown to date. Chrysler, General Motors, and Scania have shown keen interest in this design, and it will appear on a static show car in an upcoming North American auto show as a statement of one automaker's intent to build prototype fuel cell vehicles using the ADL reformer technology.

The successful development by Arthur D. Little of a multi-fuel reformer has significantly altered the discussion of fuel choice for fuel cell vehicles. Because it was designed to process ethanol denatured with gasoline, the multi-fuel reformer is also capable of processing straight gasoline. GM and Chrysler, supported by several oil companies, now advocate gasoline fuel cell vehicles as the best interim solution to more efficient, lower polluting vehicles. For ethanol interests, this is a mixed blessing. U.S. industry has become a strong advocate of this technology, resulting in greatly increased private and DOE resources directed toward the development of multi-fuel capable fuel cell powerplants. The bulk of DOE's fuel cell vehicle budget over the next three years (over $30 million) will be directed toward multi-fuel fuel cell powerplant development.

Commercialization of fuel cell vehicle technology can also occur much more rapidly using a widely available fuel such as gasoline since a national fuel infrastructure already exists. However, neither the auto companies nor the oil companies can be expected to highlight this basic fact: Any fuel processor capable of using gasoline can also be designed to utilize ethanol. Many technical aspects of ethanol fuel processing (such as carbon formation and sulfur trapping) are simpler with ethanol than with gasoline.

In 1996, Arthur D. Little continued to refine the multi-fuel fuel processor, working with major automotive companies to integrate this technology into advanced vehicle designs. Arthur D. Little (with support by the Illinois Corn Marketing Board) continued to advance the case for ethanol, a very desirable fuel for fuel cell vehicles. Our technical work program for 1996 was aimed at improving the cost associated with use of ethanol as a fuel cell fuel. We successfully operated our fuel processor on hydrated ethanol, demonstrating that a lower cost feedstock can be used. The successful results of this program have been presented in various public forums including the 1996 Fuel Cell Seminar. Appendix A includes a draft of a technical paper describing the results of our 1996 program to be presented to the Society of Automotive Engineers in March, 1997.

Objectives:

The objective of the proposed project is to ensure that ethanol remains among the most desirable fuels for fuel cell vehicles. In response to an announced solicitation, Arthur D. Little will team with a fuel cell supplier and in early 1997 submit a cost-shared proposal (for approximately $15 million) to DOE to develop a fuel cell powerplant for use in light- and medium-duty vehicles. DOE will require that this powerplant operate on gasoline. However, on behalf of the ethanol industry, we propose to add to our work plan specific design and demonstration tasks to assure that the powerplant developed in this program is fully compatible with ethanol. Specific objectives for ethanol include:

Form a competitive team (including Arthur D. Little, the Illinois Corn Marketing Board, other ethanol interests, a fuel cell developer, and other commercial companies) to successfully compete for a DOE contract for fuel cell powerplant development. Each participating organization, including Arthur D. Little, will be responsible for its own proposal preparation costs. No Illinois Corn Marketing Board funding is requested to achieve this objective.

Include design tasks in the proposed DOE work program to ensure that the powerplant that is developed is fully compatible with ethanol, ethanol blends, and hydrated ethanol.

Include explicit demonstration tasks in the proposed DOE work program to effectively demonstrate ethanol operability in the fuel cell powerplant.

Continue to underscore the positive role of ethanol in fuel cell vehicles in prestigious and visible technology and policy forums.

Procedures:

Specific tasks for the DOE fuel cell powerplant program will not be determined until DOE publishes a full RFP in mid-December, 1996. The full proposal will be submitted to DOE in early 1997. A copy of the completed Technical and Cost Proposals will be provided to the ICMB on request. As we develop the complete DOE Program Plan, we will include tasks consistent with the objectives described above.

Based on preliminary DOE program specifications, the following ethanol specific milestones can be anticipated in the ADL program plan:

The dissemination of results, is a vital step in maintaining ethanol's position as a premier alternative fuel. As shown in Table 1, there are a variety of stakeholders with different influences on the use of ethanol in transportation.

Table 1: Hydrated Ethanol Results Dissemination

Stakeholder	Role	Message	Forum
Ethanol interests including states and producers	Encourage expanded ethanol utilization	Ethanol can be a premium fuel in advanced transportation applications	Governors' Ethanol Conference
Department of Energy / Department of Transportation	Ford ethanol research and demonstrations	Ethanol is a fuel with future vision. Ethanol used in fuel cells is superior to methanol and hydrogen on an economic and technical basis.	DOE Contractors' Meeting
OEMs (Chrysler, Ford, Transit Bus Manufacturers)	Build ethanol vehicles	Ethanol can be used economically in advanced vehicles. Continued investments in ethanol vehicle technology are desirable.	SAE
Fuel Cell Technology Community	Develop advanced powerplants	Ethanol is the preferred fuel for fuel cell powerplants.	Fuel Cell Seminar, Private Briefings

There are a wide variety of forums which are appropriate to disseminating the results of this work. These forums can be selected to influence all of the stakeholders listed above. Example forums are shown above. Written papers submitted for technical meetings such as SAE and Fuel Cell Seminars can also be distributed for further impact.

Arthur D. Little's interest in dissemination of results runs parallel to the Illinois Corn Marketing Board's wishes to be seen as the premier developer of advanced fuel cell technologies. Therefore, our commitment to discussion of this promising development is quite strong. This effort is supportive of our ongoing fuel cell power system business development efforts. Therefore, much of the anticipated cost of dissemination of results will be borne by Arthur D. Little. Our costs shown are primarily for document preparation and production. Costs for attendance at conferences and meetings will be primarily borne by Arthur D. Little.

Justification:

The proposed contributions to this program by the Illinois Corn Marketing Board will ensure a more effective DOE powerplant development program in three ways:

The requested financial commitment over the course of the program will make the Arthur D. Little team more competitive, increasing our chances of successfully obtaining one of the two anticipated contract awards for fuel powerplant development. These are 25% minimum cost-share contracts and Arthur D. Little and other team members will be making cost-sharing commitments as well.

The participation of the Illinois Corn Marketing Board will reinforce the interest of the ethanol community in this program. While DOE has, for the moment, bowed to marketplace reality in adopting a gasoline-based technology strategy for initial fuel cell vehicle introduction, the use of ethanol is far more consistent with the DOE core mission.

By including ethanol-specific design and demonstration tasks, the role of ethanol as a highly desirable fuel cell fuel will be highlighted and preserved. As in the past, Arthur D. Little is committed to conducting a public and vocal discussion in technology and policy forums of the merits of the use of ethanol in advanced vehicles.

The proposed technology demonstration will position ethanol as the preferred fuel for advanced fuel cell transportation systems. This long-term vision provides strong incentive for the expansion of current ethanol IC engine applications. In the near-term, ethanol powered fuel cell transit buses will consume significant quantities of ethanol and provide continued momentum. In the medium-term, fuel cell light-duty vehicles powered by ethanol will provide an extremely robust market. A very feasible market development scenario is illustrated in Table 2.

Table 2: Ethanol Fuel Cell Vehicle Market Development

Vehicle	2000	2003	2008	2015
Fuel Cell Transit Bus				
Number of Vehicles in Operation	3	200	3,000	10,000
Gal Ethanol/yr*		1,000,000	15,000,000	50,000,000

	15,000			
Light-duty Vehicles Number of Vehicles in Operation Gal Ethanol/yr**	 0 0	 500 300,000	 5,000 3,000,000	 1,000,000 600,000,000

*E-95 equiv. based on 5,000 gal/yr per vehicle

**E-95 equiv. based on 600 gal/yr per vehicle

The above figures do not account for the strong "halo" effect that the vision of advanced ethanol applications can bring to efforts to expand ethanol IC engine applications.

Budget Summary:

The DOE fuel cell powerplant program will begin in 1997. The budget in Table 3 reflects the requested cost-share participation for the Illinois Corn Marketing Board over the three-year life of the DOE program. The greater requested allocation of funds in later years of this program reflects the anticipated spending rate for the entire program and is predicated on success in earlier years of the program. As discussed in Section C, the second and third years involve increased rates of expenditure consistent with testing of a full-scale ethanol fuel cell powerplant hardware.

Table 3: Annual Requested ICMB Contribution

Year	1997	1998	1999	Total
Cost	$75,000	$100,000	$150,000	$325,000

ADL will team with a leading fuel cell developer and other commercial firms to compete for the pending DOE fuel cell powerplant procurement. The Illinois Corn Marketing Board and possibly other ethanol interests will be shown as co-sponsors of the proposed program. No ICMB funding is being sought for the preparation of the DOE proposal.

Illinois Corn Marketing Board

Build your own laboratory quality still with an automatic temperature control valve, with an output of 20 liters/hour of 190 proof ethanol.

ABOUT THE AUTHOR

AguaLuna is an Off-Grid, Family Owned, 100% Alternative Energy / Fuel Run Ranch. We share / teach methods & projects that are designed / compiled & currently running (here on the ranch) with others, in the hope that everyone can accomplish some form of Self-Sustainability / Green Alternative Energy upgrade to their home or vehicle.

The planet IS being Destroyed & Global Warming is no longer questioned. Simply flip through your TV or pick up a newspaper, the subject makes headlines daily...

Global Warming
Melting ice sheets & glaciers
Floods & droughts
Great hurricanes & cyclones

Seasonal extremes
Seasonal phenomena's
Species extinction
New & resurgent diseases

These catastrophes are Natures Natural WAKE UP call & we all need to Answer It !

Advancements in technology & information make going green A LOT easier today. For example, Using Alternative Energy's like Ethanol (corn oil), Biodiesel (fry grease), Hydrogen (water), Solar Power, Wind Power, Water Power, etc., instead of polluting & harmful fossil fuels, is an extremely simple, cheap & HUGE step.

What's better then a cheaper, safer & healthier alternative to Global Warming ? The earth provides for us unlimited FREE Energy, why not use it ?

My husband & I have lived 100% Off the Grid & Bill & Debt Free on our ranch in West Texas for the last 8 years. My husband (a retired Engineer from Boeing Aerospace) has written, compiled & built every project we offer in our Alternative Energy Guides collection, which are all available for viewing / testing in our On-Site Workshop. This is why we not only believe 100% in our Alternative Energy Guide Collection, but are capable to offer FREE unlimited online consultation at no extra cost, with every guide purchased, like no one else can over the Internet. We are standing by to walk you step-by-step trough ANY problems you may experience in building your own Alternative Energy items.

CLICK http://s37.photobucket.com/albums/e88/arcious/Hacienda_Agua_Luna/ to meet us & visit the ranch, where we live completely self sufficient. Let us share our knowledge & experience with you & your family.

And don't forget to check out other Alternative Energy Guides
http://www.agua-luna.com/guides.html
We've formatted them in an easy to read, step-by-step way to provide EVERYONE, ANYONE, EVERYWHERE an abundant amount of information, while having in mind all skill levels & have designed the booklets to suit each individuals needs from the beginner to the expert. Titles include...

How to build a Wind Generator
Building a Windmill
How to find Free Solar

How to build a Solar Stove
How to Build an Arc Welder

DIY Biodiesel
Build a $10k 5,000sqf home
DIY Automatic Animal

How to Convert your car to EV
How to Run your car on Ethenal

Panels *Building a Solar Panel*	*How to Live off the Grid* *Build a Solar Water Heater*	*Feeder* *Super Cooler Plans*	*Build an Alchohol Still* *Build a Solar Panel*

... & Much more, specifically written to better assist your Living off the Grid / Alternative Energy Experience.

> **Note:** *For the best savings we Highly Recommend our Feature 40+ Package. It contains over 40 Alternative Energy / Live off the Grid Booklets for the price of just 5. The 40+ Package will kick start you into your NEW Alternative Energy Life Style & will guide you to help us STOP GLOBAL WARMING.*

Because our life style here at agua-luna.com Ranch is 100% Lived Off the Grid, we are familiar with the Day-to-Day aspects of Self Sustainability & how simple it is to actually make the conversion. No one else can offer that.

If you're interested in making your first GREEN steps with our help, we offer a number of affordable options. First take a tour through the site, then check out our instructive Alternative Energy Guides, & if going green sounds good to you, sign up to join us here on the ranch & take part in our On Site Workshop or Online Workshops, gain experience in our Internship Program during one of many Sustainability Projects, catch an Alternative Energy Seminar in your area or simple stay in one of our cozy 100% Off-Grid Cabins, experiencing nature's stress free landscape & what Living Self sufficient / away from society's rat race has to offer.

Because agua-luna.com is a non-profit, 100% Alternative Energy Green Off the Grid run Ranch. All purchases & donations go strictly to costs incurred & future expenses in providing the newest Eco minded projects & information to a larger array of people, in the hopes of helping as many as possible in making some form of Green conversion.

About the Agua-Luna On-Site Self Sufficiency Workshop…

The following procedures are recommended for both first-time enrollees and those who have already experienced a seminar or have previously taken a course/s with agua-luna.com:

AguaLuna Ranch in Far West Texas is an Off-Grid Eco orientated and Green run Ranch, dedicated to creating learning communities for on-going professional sustainable development. Members of the agua-luna.com On-Site Workshop, who are driven by all things environmentally friendly, work to teach others Green and Alternative ways through hands on courses. We invite you to sign up for our Summer Workshop and make the conversion now.

AguaLuna Workshop Information

The Workshop will consist of a series of lab and on-site based tutorial lectures and projects covering alternative energy and / or self sustainability, including past, present, and future applications and techniques, particularly in its application in making the Environmentally Greener conversion.

The workshop will be held on-site at the AguaLuna Ranch. See dates, fee's and course topics at www.agua-luna.com

The Workshop is intended for first-timer enrollees or repeat offenders who are motivated to make an environmental difference in their own lives and in the lives of those around. Travel and accommodations information is available upon request agua-luna@lycos.com Local / primitive camping accommodations, on the Ranch, may be provided at no charge, upon request, to participants for the duration of the workshop.

Participants earn their Green Certificate certifying their knowledge of the latest in "green" building practices, technologies and techniques.

The topics will address economic, ethical, environmental and social aspects of some form of self sustainability and / or alternative energy. Specific topic based projects will be taught and carried out by attendees in a hands-on safe environment. Each of the workshops will feature a 1 week (4 hr/day) eco based component, entirely devoted to some form of Alternative Energy Concepts and is meant as an introductory course to the world of Green living.



Next Step: Download and Fill out the work-shop sign up form by clicking http://www.agua-luna.com/workshop_form.pdf or send an email to the address below requesting the form. Feel free to include any information you feel pertinent.
Send completed applications to:
agua-luna@lycos.com
or
AguaLuna
Hc 65 276 G
Alpine Tx
79830

AguaLuna Workshops

Alternative Energy Concepts Workshop
$480 per week (fee covers all project materials and lab costs)

This workshop course is directed towards the average person who wants to gain a basic knowledge of Alternative Energy. Participants will learn Passed, Current and Future Energy and fuel resources, alternative fuel and energy options, alternative fuel and energy conversion, and more. Participants and Instructors will prepare and perform theoretical, lab and on-site presentations, examples and projects, leading the learning experience.

Home Small Scale Hydrogen Generation Workshop
$480 per week (fee covers all project materials and lab costs)
This workshop course focuses on the basics of Small Scale Hydrogen Generation and how it can be applied safely in the average Home, vehicle and daily use. The basic technical knowledge and skills in this workshop will be useful in helping family and consumers better understand and incorporate Hydrogen as a safe fuel, limiting if not extinguishing their need for fossil fuels. Hands on electrical and chemical Hydrogen generation will be featured. Participants and Instructors will prepare and perform theoretical, lab and on-site presentations, examples and projects, leading the learning experience.

Self Sufficient House Construction Workshop
$480 per week (fee covers all project materials and lab costs)
This course is designed for any interested in specific techniques and construction methods, utilizing natural or eco friendly materials. The focus will be on material properties in their relationship to different locations, climates and accessibility, but other topics relevant to both environment and human health / need will be covered. Specific topics include different methods in working with and building homes out of Adobe, Cob, Pole, Rock, Papercrete, Recycled materials, Rammed earth, Hay bale Cordwood, Underground and their ecologically-friendly impact on the terrain. Participants will work in the lab as well as hands on through activities and case studies to improve their knowledge and skill in building sustainable / eco friendly, green homes.

How To DIY Wind Generator I Workshop
$480 per week (fee covers all project materials and lab costs)
This course is a workshop focused on the basics of Wind Generations and how it can be applied to the home. The basic technical knowledge and skills in this workshop will be useful in helping the consumer better understand Wind technology as a useful form of electricity and how it will affect their need for alternative energy. Laboratory investigations, instruction and projects will give participants experience with energy extraction and transformation, conversion, practicality, incorporation, maintenance, and more. The course focuses on history, theory, environmental need for, and home applications of the wind turbines as a viable source of needed electricity, with several small hands-on projects carried out. This course is a pre-request to help understand "Practical Wind Generator use and construction" which will be covered in the "How To DIY Wind Generator II Workshop"

How To DIY Wind Generator II Workshop
$480 per week (fee covers all project materials and lab costs)
This advanced workshop is only open to those who have attended one of the previous "How To DIY Wind Generator I Workshops". Attendees will learn how to prepare, construct and install advanced Practical Wind Generators for home or business use. Activities will include parts description and location, generator construction, How to Build your own blades, pole raising, wiring, battery banks, inverters, and more. Participants will prepare and perform preparation lab activities in class, carrying out the remainder of the project in an on-site construction environment.

What to bring:
The weather in Texas is very volatile so bring lots of layers of clothes you don't mind destroying at work, sturdy closed-toed work shoes, sunscreen and a hat with a wide brim to protect you from the intense sun.

- Leather work gloves
- Heavy duty rubber cement gloves

- Safety Glasses
- Ear plugs
- Dust masks
- Hammer
- Utility knife
- Retractable tape measure
- Tool belt

How To Build your own Solar Panels I Workshop

How To Build your own Solar Panels II Workshop

Can't make the On-Site Workshop? Self Sufficiency Workshops are now available online. See below for details, dates and pricing or contact us at agua-luna@lycos.com.

AguaLuna Self Sufficiency Online Workshop / Course

AguaLuna's popular Self-Sufficiency Workshop courses have been updated and will now be offered starting this year online. The courses are designed for first-timer enrollees or repeat offenders who are motivated to make an environmental difference in their own lives and in the lives of those around.

The courses, taught entirely on the Internet, gives participants the knowledge, background, resources, and confidence they need to carry out alternative energy / self sufficient upgrades to their life, home and vehicles. A minimum of 15 hours online, plus an additional 15 hours of reading, writing, research, projects and taking exams is required for each course.

Participants earn their Green Certificate certifying their knowledge of the latest in "green" building practices, technologies and techniques.

All course work can be done on a home computer. Course participants will be introduced to ethical theory before moving on to evaluating self-sufficiency and alternative energy issues. The course incorporates activities on specific topics about environmental solutions, carbon foot prints, self sufficient building, and alternative energy. Course participants are welcome to use these activities in their own teaching or outreach work as long as that work is not for profit. There will be extensive online discussion with other enrollees.

Dan Martin, a retired Boeing Engineer who majored in Theoretical and Structural physics now living 100% Off-the-Grid, The Author of 10 How to DIY Self Help / Self Sufficiency / Alternative Energy Guides will be this instructor. For more information about this years course content, please contact him directly attn: Dan Martin at agua-luna@lycos.com or visit www.agua-luna.com.

Simply Download and Fill out the work-shop sign up form by clicking HERE or send an email to the address below requesting the form. Feel free to include any information you feel pertinent.
Send completed applications to:
agua-luna@lycos.com
or
AguaLuna
Hc 65 276 G
Alpine Tx
79830

For more details about the agua-luna.com workshops, please contact us agua-luna@lycos.com or call 206-333-0321, leave a message with your phone number and email.

Again, I thank you for your interest in our programs. I hope you will be able to join us this summer.

AGUALUNA INTERNSHIP INFO

The agua-luna.com Internship program is open to anyone with an interest in sustainability / alternative energy and a willingness to work hard. People of all ages and backgrounds are encouraged to sign up.

Six applicants will be chosen for each session (schedule at www.agua-luna.com). Accepted interns will have the opportunity to learn alternative eco friendly building concepts and techniques while working full time alongside the agua-luna Mentor Team for approximately 1 month to 2 months.



Internships are unpaid positions. Interns are responsible for providing their own accommodations, food, transportation, supplies, etc. or primitive camping and meals are available at no charge on-site.



There is no application deadline.

During the session interns may attend any scheduled on-site workshops and seminars. Upon completion of the session interns receive a Certificate of Clean Green Building, and the new found skills of environmental construction.

Note: All applicants will receive a response.



What to expect:
Each session will start with a brief orientation meeting at the Agua-Luna Visitors Center. This will include a small tour of the Agua-Luna Ranch, projects and potential work sites, showing a few finished projects as well as the job site where you will show up for work at 9 am the next day.

Expect to be challenged physically and mentally, to work hard and play hard. Some have found it difficult to be away from their

homes and jobs for a month. Please come prepared to support yourself for the entirety of your stay. Also, please keep in mind you will be working on a construction site.

What to bring:
It is very difficult to attend an internship without a vehicle as the Taos area is so spread out. Interns have gotten by with carpooling with other interns and/or hitchhiking, but it can be a challenge.



The weather in Texas is very volatile so bring lots of layers of clothes you don't mind destroying at work, sturdy closed-toed work shoes, sunscreen and a hat with a wide brim to protect you from the intense sun. If you are camping you'll want a tent, a tarp, a campstove (open fires are ok), a sleeping bag, a five gallon water jug, a good flashlight, etc.

Tools: Having a few simple tools will make your internship more comfortable and add a wider variety of work. Here is a list of some helpful tools you can choose to bring (all tools are supplied).

- Leather work gloves
- Heavy duty rubber cement gloves
- Safety Glasses
- Ear plugs
- Dust masks
- Hammer
- Utility knife
- Retractable tape measure
- Tool belt
- Any other hand tools may be useful, i.e. a speed square, combo square, bevel square, chalk line, torpedo level, pliers, chisel as well as small power tools (drill, circular saw)

Participants earn their Green Certificate certifying their knowledge of the latest in "green" building practices, technologies and techniques.

Next Step: Download and Fill out the internship application by clicking http://www.agua-luna.com/internship_form.pdf or send an email to the address below requesting the form. Feel free to include any information you feel pertinent.
Send completed applications to:

agua-luna@lycos.com
or
AguaLuna
Hc 65 276 G
Alpine Tx
79830