HOW TO SWITCH OVER TO 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 discus Alternate concepts to simplify daily activities, methods to save energy, avoiding Main Stream utilities, making *LIFE SIMPLER* by *SWITCHING OVER TO 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 how to switch over to 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.

CONVERTING GASOLINE ENGINES TO RUN ON ALCOHOL

You can make you own E85 fuel!

If you want to use your home-made ethanol in your car as E-85 (85% ethanol and 15% gasoline, before you mix it with gasoline, it has to be 100% pure: 200 proof. This will be a high octane fuel: about 102 octane. You may get about 10% less mileage as there is technically less energy in alcohol than gasoline. If you increased your compression and do everything to optimize your engine for alcohol, it will actually get better mileage and/or more power, as a higher octane (slower burning) fuel is more efficient. But even though the Charles 803 still will make 194 proof, first time, every time, you can never remove that last 3% of water using a still of any kind. You will need to use a molecular sieve. This sounds technical, but it is real easy. Just read this letter I got from Dr. Grant Carlson with Eco-Rebuilders. "Since we remanufacture old third generation Corvettes with big horsepower-high compression-fuel injected engines, homemade E85 is important to our customers. A molecular sieve is just zeolite: link to information about the manufacturer we use is shown here. 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 5lbs 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.

http://www.thomasregister.com/olc/60852852/m_sieve.htm

Excerpt from Roger Lippman's book on converting VW engines, c. 1980.

This outlines an approach to engine modification generally applicable to four-stroke carbureted gasoline engines. (Not covered are fuel-injected, two-stroke, or diesel engines.) While it cannot give specific calibrations, due to the wide variety of engine configurations, it offers a sense of the scope of the task and provides a place to start.

Chapter 3 presents specific information for the conversion of an air-cooled Volkswagen engine (circa 1980). (See link at bottom)

It is understandable that people may want to use an older engine for this experiment. There is the risk, however, of problems due solely to worn-out parts developing after the car is converted. It is important to be able to distinguish these from problems that may be due to the ethanol or to an error in modification. So it is recommended that the engine selected for modification be in the best condition possible.

The first question to consider in approaching engine conversion is whether

there are any materials in the fuel system or related systems that will be damaged by ethanol. It would be most unfortunate to pour ethanol in your tank and have parts of the carburetor dissolve.

Metals commonly used in fuel systems are usually ethanol-compatible. Magnesium is known to suffer severe corrosion when in contact with ethanol. Fortunately, it is rarely found in fuel systems. Among non-metals, cork does not fare well with ethanol. Polyurethane and fiberglass-reinforced polyester have also been known to deteriorate in ethanol. Avoid plastic fuel filters - the glass ones are preferable. Aside from these items, non-metal problems with ethanol are unlikely.

Take your fuel pump and carburetor apart and clean them; soak them for a month in 180-190 proof ethanol. (If you can't afford to have your car apart that long, pick up used parts from an auto wrecker.) Likewise, soak a fuel filter and a piece of fuel hose. Agitate the container from time to time. When the time is up, look for pitting or corrosion of metals. Check non-metals for softening, hardening, cracking, or change of size, shape, or weight.

If preliminary tests indicate materials problems, consult your local auto parts store, carburetor specialty shop, racing supplier, or machinist regarding suitable replacements.

It may be that some fuel system parts will deteriorate slowly in service. Be alert for this possibility as you are running the vehicle on ethanol. Also, impure fuel can cause unanticipated difficulties. Beware especially of overly acidic fuel (pH less than 6)

It is also important to watch parts peripherally related to the fuel system that may be exposed to ethanol vapors, such as vacuum advance diaphragms, automatic transmission modulators, and power brake assist units. Problems here are unlikely but worth watching for.

Because ethanol is a dirt loosener, it will free dirt that has accumulated throughout the fuel system. For this reason it is important to install a fuel filter before the pump, and another between the pump and the carburetor. Use the cleanable type, and check it often in the first weeks of ethanol use.

Finally, note that ethanol spilled on the vehicle paint finish may have adverse effects. Paint softening and wrinkling have been experienced in some cases.

The carburetor meters the flow of fuel to the cylinders and mixes the fuel with air. Because ethanol supplies less energy per unit of volume than does gasoline, fuel-metering jets must be enlarged to allow the proper amount of fuel to pass.

There are many carburetor designs in use, and it is not possible here to give specific directions for all. It will be necessary for you to experiment in the context of the guidelines provided here.

Start by calculating the factor by which your jets must be enlarged. The formulas in Appendix B indicate that jet diameters for gasoline should be multiplied by 1.27 for pure ethanol (200 proof). Most people, though, will be using 180-190 proof. Unfortunately, the formulas do not seem to give accurate answers for hydrous ethanol. Start out about five per cent larger than the figure you calculate.

Obtain a carburetor rebuild kit, which will include a detailed diagram of your unit. Clean and overhaul the carburetor since you will have it apart anyway. Identify all fuel metering jets, including: main jet, pilot (idle) jet, and accelerator pump nozzle.

Most jets are stamped with the orifice diameter in metric or English units. On a metric carburetor, a number such as 120 means 1.2 mm.; on most U.S. units, 50 indicates .050 inch. There are exceptions; check with a carburetor shop to be sure. Convert millimeters to inches by dividing by 25.4.

Multiply your jet sizes by the conversion factor. Obtain new jets of the proper size, if available, from a parts or racing equipment supplier. Often they will not be available, and you will have to drill out the old jets yourself. Determine the proper drill bit sizes from the chart in Appendix C. Obtain the bits and a pin vise from a tool supplier. Do not use an electric drill. Carefully enlarge the jet, wash it, and blow it clean with compressed air.

Some carburetors incorporate a staging adjustment for the accelerator pump. This controls the duration and quantity of fuel injection from the pump. In addition to enlarging the nozzle, lengthening the pump stroke may help.

Because ethanol is 7 to 8 per cent heavier than gasoline, it may be necessary to adjust the float setting to maintain the proper level of fuel in the float bowl. Otherwise the fuel level will be too low. Bend the float up slightly or use a thinner gasket under the needle seat. As an alternative, find a slightly heavier float.

On cars with automatic chokes, adjust the choke unit to a winter setting. When the engine is running again, adjust the idle and mixture screws.

Carburetor modifications, especially jet sizing, will be a matter of some trial and error. With jets it is better to start small and work up. If you go too far, you can buy a new jet and try again. You can judge your results by comparing power and CO emissions with gasoline operation. Both should be similar.

Power is also affected by other factors, as we shall see.

Below 60-65 degrees F., ethanol will not vaporize sufficiently to form a combustible mixture. The simplest way to start a cold engine is to inject a more volatile fuel into the intake manifold or carburetor. Gasoline and propane are good candidates. Straight ether is not recommended, but there are ether formulations - used for starting diesels--in which the tendency of ether to explode all at once is modified.

A gasoline cold-start system consists of the following components: Fuel tank. A one-gallon motorcycle tank will do. Install it in the trunk where it is well protected in case of accident and away from engine heat. Secure it well.

Fuel line. A metal tube runs from the tank to the engine. Install it so nothing rubs against it. An in-line fuel filter should be installed near the tank.

Pump. An electric or manually controlled pump should be installed in the line where convenient. You will need a switch or other control on the dashboard. Beware of pumps not designed for gasoline, such as windshield washer pumps. The plastic and rubber parts may degrade when used with gasoline.

Nozzle. Connect the fuel line to a small nozzle with an opening about the size of the accelerator pump orifice in the carburetor. This nozzle can be installed in the air cleaner, pointing straight down the carburetor throat, or in the intake manifold.

A propane system is constructed as follows: Fuel tank. Buy a propane-torch kit, which includes the tank and a pressure control valve. The orifice in the tube, after the valve, should be drilled out somewhat to allow an adequate flow of propane. Mount it away from the engine compartment.

Control valve. Propane is stored at high pressure - over 200 psi - so a special electric valve is required to control it. This is available from a valve supply shop. It is recommended that the valve be brazed to the neck of the pressure control piece to insure against leaks. A switch on the dashboard, preferably with a warning light, is wired in to activate the valve.

Fuel line. Tightly clamp a fuel hose to the electric valve and connect it directly to the intake manifold or carburetor in a convenient place.

Note: With either the gasoline or propane system, inject fuel for just a few seconds, while starting the cold engine. It will run on ethanol alone almost immediately.

Preheating engine coolant is an alternative approach. In engines that incorporate a water-heated manifold, a small electric water heater installed as

close to the manifold as possible will improve cold starting. Such heaters are often used on gasoline engines in cold climates and are commercially available. Of course, you have to plug it into the wall and wait.

Improved spark quality, as discussed below, also aids in cold starting.



Ethanol-powered Le Mans race car, team Nasamax's DM139 LMP1

Suffolk, United Kingdom - July 28, 2004

The description might sound like a bad joke, but the DM139 LMP1, Judd V10 is fast and black and "green" all over. So fast, in fact, that the Nasamax racing team placed 17th out of 26 cars to finish at this year's Le Mans 24 hour race with the DM139, which runs entirely on bio-ethanol fuel. It was the second year the team qualified for international motor sport race, but the first year the drivers took it to the line to become the first team to place with a car run on alternative fuels.

"It's very interesting out there. There are people flying off all over the place, perhaps a few who are new to Le Mans," night driver Werner Lupberger said.

The Kent, England based team has a core of experienced scientific and racing personnel who belong to an international racing program designed to promote low-emission renewable fuels. Motor sport racing is a big industry and a big fuel consumer, and not what many people think of as environmentally friendly.

Development partners for the green fuel venture are Applied Sciences Technologies (ASTEK) and Cosworth Racing. ASTEK is a research and development company that specializes in renewable and sustainable technologies. They have developed technology for the use of alternative fuels

in internal combustion engines, and methods for the production of bio-ethanol from cellulosic materials. Fuel for the DM139 engine is made from sugar beets and potatoes grown in Northern France.

Cosworth Racing is a division of the Ford Motor Company, and they designed, developed and manufactured the XDE engine used by the Nasamax team. They are renowned for their Formula One engine development for teams such as Jaguar and Jordan as well as for the WRC Rally program.

"This is the first time for years Cosworth Racing has been involved on a factory support basis in sports cars. It also marks the first time we have used renewable fuel, bio-ethanol, in a racing engine and it is very exciting to be spearheading this technology," said Nick Hayes, Managing Director for Engineering at Cosworth Racing.

Cars that qualify for the LeMans have to meet race regulations, so the Nasamax team had to work on ways to meet the regulations while ensuring the DM139 could compete with the other cars in terms of tank capacity and fill rate during refueling. Bioethanol fuel contains only 75 percent of the energy of the same volume in gasoline, so the car needed 135 liters of tank capacity to carry more of their 200 proof fuel than a standard racecar.

Information on the team's Web site used a comparison of coffee and espresso to explain why a greater volume of ethanol (coffee) is necessary to run the DM139 for the same amount of time as a car run with fossil fuels (espresso). An espresso carries a certain amount of caffeine in a small quantity of drink, while regular coffee will carry the same amount of caffeine but in a greater quantity of the drink. If caffeine intake were the goal, then a person would need to drink more coffee than espresso. If fuel combustion is the goal, then a driver needs more ethanol because the efficient fuel burns up faster than fossil fuels.

Engine performance with ethanol was everything the team could have asked for, but regular racing setbacks kept the car from moving up any higher in the race ranks. Regular tire changes, a starter replacement and a persistent misfire made the team lose laps.

"We lost time trying to find the misfire and eventually we had to just get on with it," McNeil said. "It's frustrating as we know what lap time we could have had, and we know it would have put us safely in the top ten, even the top six. However, these were the usual setbacks any car could have in racing, and we have still shown that this fuel can be competitive in the top level of international motor sport. To do so with a new racing car to completely new regulations is also a major achievement for the whole team. We will be back

next year."

The three drivers completed a total of 316 laps around the 8-mile race circuit at Le Mans. McNeil estimated they lost about 41 laps to pit stops for the misfire. Le Mans takes place every year in the Sarthe region south west of Paris, and has always been a showcase for the debut of new technologies in the harshest competitive environment in motor sport. The 8-mile circuit is a mix of permanent track and roads.

2.7L Chrysler Sebring Convertible, runs on E-85



This car is designed to run on 85% ethanol.
Click on photo to a list of E-85 ready cars.

You may already be driving a Flexible Fuel vehicle (FFV) and not know it!

Things have changed a lot for engines made in the last ten years: most cars now already have a computer chip that controls the fuel injection and timing. Many are already setup to use E-85 fuel (85% Ethanol and 15% gasoline) with no change to the engine whatsoever! The built-in O2 sensors measure the Oxygen content of the fuel (since there are a lot of fuel blend combinations, according to if it is summer or winter, or which state you live in). This means that you can make your own E-85 and go. When you need to re-fuel, just buy normal gasoline again, and the engine will automatically compensate. This is what a Flexible Fuel vehicle is all about. But check with your owners' manuel before you try this, or ask the mechanic at your dealership.

FFV's (Flexible Fuel Vehicles), factory ready to use E-85, are widely available. Approximately 2 million FFV's 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/

The other thing that has changed a lot since I first started promoting ethanol back in 1980, is that it is now easy to buy Zeolyte and turn your 180 or 190 proof into

Dedicated E85 Truck by U of Texas students



UTEP took 4th in the 2000 Ethanol Fuel Challenge

200 proof (anhydrous) alcohol, so that it will mix OK with gasoline.

Converting a Chevy Silverado with fuel injection to run on E-85
This is a very good report on all the things necessary to convert a modern engine to be compatible with ethanol. This is a very long page, so scroll down near the bottom to see how they modified the fuel injection and delivery system for both safety and performance.

Alcohol fuel has been around for a long time.



This is an actual ad for Studebaker Trucks!

[Adapting your engine for ethanol]

This above link is an out-of-print article published by Mother Earth News, on how to adapt your engine for alcohol. It also provides a list of materials compatible with ethanol.

The petroleum industry has a lot of reasons why we shouldn't even think about using a different fuel, and actually put out a lot of mis-information. Check out this link below for more technical info on alcohol and other fuels.

http://www.ethanolrfa.org/auto_mechanics.shtml

Engine modifications for Volkswagons



© Love Street Books, art by designed by Greg and Diane Harper



Appendix A Fuel properties
Appendix B Formulas
Appendix C Drill size chart
Appendix D References

http://terrasol.home.igc.org/alky/alky-appendix.htm

How pure do you want it?

Dear Robert
Thank you for the Charles 803 Alcohol Fuel Still plans they arrived on the 18th of January. They are superb, excellent detail. I will definitely let you know how I get on with its construction, although probably not for a little while.
Many thanks
John

To: robertwarren@mail.com

Subject: How efficient are your stills?

Sir-

I found your work... nicely done. I have been toying with the idea of alcohol as a fuel source for a while but I live in Seattle, Washington. I don't imagine a solar still would work in the land of overcast skys, and using non-renuable energy to run a still seems silly. It was looking for the answer to this question that I found your site. Can a still be efficient enough to use its alcohol to run it? If so, how much alcohol "profit" is there?

Unlike other "free energy" ideas, this one doesn't seem (at least at first glance) to be an obvious violation of physics. I mean, after all, there is a huge nuclear reactor sitting just a quarter of a billion kilometers away pumping new energy into the system.

Do you know the answer?

Thank your for your time,

Cheers!

Eric

Eric,

I only used propane to boil my mash when I needed a portable source of fuel for doing energy fairs and such, but mostly I have always used scrap wood -- dumpsters and dead fall in the woods. I found that even if my efficiency wasn't the greatest, I still had something clean and powerful to put in my gas tank.

When you get into making it commercially efficiency really matters.

My very first still, 27 yrs ago, was a solar still, but it only made a pint /day. I have been in the solar industry for 25 years, but if it is fuel for your car, you can't beat ethanol.

Look into it a bit more... it is almost a lost art.

Robert Warren



Porsche



4. SPARK QUALITY

Because the ethanol fuel-air mixture tends to be poorly vaporized under some conditions, it is useful to use a better ignition system than the conventional breaker points triggering system provided until recently on most cars. Factory electronic or high-energy ignition is satisfactory. But if your car does not come with this type of system, it is worth obtaining an aftermarket capacitive discharge or electronic ignition unit. These can be installed easily, and they increase the voltage at the spark plugs and keep the plugs cleaner.

Some difference of opinion exists on the question of spark plug heat range. It is best to start out with the plugs designated for your engine. For hot weather and long distance driving, though, it may be beneficial to use plugs one or two levels colder. If you do, check the plugs to be sure they are not being fouled by oil.

5. IGNITION TIMING

Other conditions being equal, the proper timing for an ethanol engine is five to eight degrees advanced from the optimum gasoline setting. But as you make changes described in this chapter, you will change factors that affect the proper timing. Improved manifold heating and increased compression ratio require retarding the timing. So does enriching the fuel-air ratio. With a moderate increase in compression ratio and manifold heating, ignition timing will be more like three to five degrees advanced from the ideal gasoline timing.

Gasoline engines without emission controls (through 1967) come with optimum spark timing.

On most 1968-70 cars, timing was retarded to reduce emissions of oxides of nitrogen (NO_x). Ethanol combustion produces much less NO_x than gasoline, so it is acceptable to advance the timing more on these cars to regain the efficiency and drivability lost to retarded timing.

Starting in 1971, automakers used a variety of devices and concepts - some of which include spark-timing controls - to reduce NO_x. How you adjust the timing on these cars will depend on the components of your emission control system and is beyond the scope of this book.

A gasoline engine will knock if the timing is too advanced, but not so with ethanol. Unless you have use of a dynamometer, the best way to check your timing setting is on the highway. Time your acceleration from about 30 to 55 MPH with a three-degree advance, and keep advancing the timing until you get the fastest acceleration time. The minimum spark advance for best power is your goal

6. COMPRESSION RATIO

Ethanol's high octane rating allows a much higher compression ratio (CR) than can be used in a gasoline engine. A typical gas engine these days has a CR of about 8.5 to 1, while a reasonable goal for a converted engine would be 10 or 11 to 1. Increased CR improves engine efficiency. Modified engines in this country have run as high as 14 to 1, but pre-ignition, reduced efficiency, and increased emissions can become problems at such high ratios.

There are two usual ways of increasing the compression ratio.

Piston replacement. Stock pistons with flat or dished tops can be replaced with domed pistons, which reduce the size of the combustion chamber and thus increase CR. They are often available from racing suppliers. If money allows, this is the preferred alternative.

Cylinder head machining. Milling the cylinder head surface also reduces the combustion chamber volume. Possible piston-valve interference and rocker arm geometry problems must be taken into account. On a V-engine, intake manifold alignment with the heads must also be considered. Consult an experienced machinist.

In either case, determine engine bore and stroke, and the combustion chamber volume before and after, to calculate the change in compression ratio.

7. FUEL VAPORIZATION AND ENGINE WARM-UP

To operate properly, an engine must be provided with a fuel-air mixture that is mostly vaporized. A gasoline engine is designed to provide adequate heat to the intake manifold, from exhaust or cool-ant, to vaporize the fuel; ethanol requires about five times as much heat to vaporize the proper fuel-air mixture than gasoline does.

The best engine configuration for manifold heating incorporates the intake and exhaust manifolds together on the same side of the cylinder head, allowing heat to flow readily from the exhaust to the intake manifold. Typical of this design is an in-line 6 and, in fact, the Dodge/Plymouth slant-6 has proven to be an excellent engine to modify for alcohol use.

On the other hand, in an engine with the intake and exhaust manifolds far apart, fuel vaporization is less satisfactory. Examples of this type are cross-flow head designs (intake and exhaust on opposite sides of the head), air-cooled VW, and V-engines.

Unless steps are taken to improve fuel vaporization, performance and fuel economy will suffer, and wear will increase. Several approaches to improving fuel vaporization can be considered. The best one will depend on your specific engine design.

Take water from the cooling system and route it through a ¼" copper tube wound tightly around the intake manifold runners. Then provide a return to the cooling system. You must choose the pick-up and return points to provide a pressure differential, so that the water will circulate through the tubing rather than just sitting there.

A similar approach can be taken with exhaust gas. Install a pipe fitting in a high pressure area in the exhaust manifold, near the head, and conduct the hot gas through a ½" copper tube to the intake manifold. Braze the tubing to the intake manifold runners, and then connect the tubing into a low-pressure area of the exhaust system, preferably below the muffler. You may wish to pick up exhaust gas at several points with several tubes from the exhaust manifold.

Alternatively, route the copper tubes inside the manifold runners. It may be necessary to use tubing smaller than ½". The tubes must run continuously through the manifold so that no coolant or exhaust gas is cycled into the fuel mixture. Drill holes for tubing entrance and exit, and after installing the tubes, braze the holes shut.

The advantage of this variant is that heat is available to vaporize the fuel mixture more quickly than if the manifold must be warmed first. The disadvantage is that the tubes reduce the volume of fuel mixture flow to the engine, which reduces power at full throttle.

If your car has a water-heated intake manifold, it may be possible to increase the flow of hot water through the manifold heater. This can be done by increasing the size of the water entrance and exit ports, or otherwise modifying the manifold. Also, installing a hotter thermostat will help here. This also improves fuel vaporization within the combustion chamber.

Most engines have a heat-riser control valve. You may be able to modify the controls on it to increase manifold heating. Above all, make sure that the valve is working properly. Often it gets rusty and sticks in one position.

Many engines have a thermostatic control or flapper valve on the air filter intake, to admit hot air under certain circumstances. You can adjust the control to provide hot air to the carburetor more of the time.

Even if you aren't working on a Volkswagen, read the next chapter. The procedures detailed there will help you develop your own modification plan. You will also pick up information - most of it useful - in talking with an automotive machinist or a racing equipment supplier.

Then fill in the gaps. Write down the specific changes you will make to the fuel and ignition systems. Devise a plan for cold starting and raising the compression ratio that best suits your engine.

After you have converted the engine, repeat the tests you did in preparation for conversion. And don't be afraid to keep tinkering. A little adjustment here and there may improve performance a lot.

BASIC STAPS OF ETHYL ALCOHOL PRODUCTION

Basic Steps in the Production of Ethyl Alcohol

THE usual sources of raw material for alcohol production from starch are cereal grains such as corn, wheat, rye, barley, milo (sorghum grains), rice, etc. Other types of starch are available from potatoes of all kinds, Jerusalem artichokes, and other high-starch vegetables. Starch conversion is the standard method of production and the one we will discuss here.

It is possible, however, to make alcohol from sugar-producing plants (saccharine material) such as sugar beets, sugarcane, fruits, and others. These substances need no milling (as do grains), but they do require some kind of grinding or squeezing process. Rapid, efficient fermentation of these sugars has not been as well explored as the process using starch.

A third source of fermentables is cellulose, as found in wood and waste sulphite liquor. This more complex process requires the use of acids to reduce the material to wood sugars. Consequently, most do-it-yourselfers should stick to either starch or sugar.

MILLING

All grains must be ground before mashing to expose the starch granules and help them remain in suspension in a water solution. The grain should be ground into a meal -- not a flour! -- that will pass a 20-mesh screen. On a hammermill, however, a 3/16" screen will suffice.

Potatoes and similar high-moisture starch crops should be sliced or finely chopped. Since potato starch granules are large and easily ruptured, it isn't necessary to maintain the hard rapid boil which is required of the tougher, dryer "flinty" starches found in grains.

CONVERSION WITH ENZYMES

For small batches (5 bushels or less), fill the cooker with water (30 gallons per bushel), and add the meal slowly, to prevent lumps from forming. (When, cooking with steam, or at higher temperatures, it is possible to save energy by using less water at the beginning. But for the "small batcher" with an ordinary cooking

apparatus, the most complete conversion is obtained by using the full amount of water right from the start to encourage a rapid rolling boil.)

Next, add 3 measuring spoons -- as provided -- per bushel of Alpha Amylase Enzyme (mixed in water) to the mixture and raise the temperature of the mash to 170 deg F (77 deg C), the optimum working environment for the enzyme. Hold the solution at that temperature for 15 minutes while agitating it vigorously.

At this point all the starch available at 170 deg F has been converted to dextrins, so it's time to raise the temperature of the mash to the boiling point. The concoction should be liquid enough to roll at its own rate -- if not, add 2 to 3 gallons of water. Hold the boil for 30 minutes to complete the liquefaction stage. All the starches are now in solution.

Now reduce the temperature to 170 deg F, using the cooling coil, and add 3 more measuring spoons per bushel of Alpha Amylase Enzyme (mixed in water). After 30 minutes of agitation at this temperature, all the previously released starches will have been reduced to dextrins, thereby completing primary conversion.

During secondary conversion the dextrins are further reduced to simple sugars (maltose and glucose) by the beta, or -- to be more exact -- glucoamylase enzymes. You need Alpha Amylase Enzyme and the yeast necessary to carry out secondary conversion and proper fermentation simultaneously, you can add 6 measuring spoons per bushel of the fermentation powder (mixed in water) as soon as you've brought the temperature down to 85 deg F (29 deg C) using the cooling coils.

CONVERSION WITH BARLEY MALT

Instead of using commercial enzymes, it is also possible to affect conversion by employing barley malt -- at the ratio of 15% by weight, or 7 pounds per bushel -- in both the pre- and post-boil. However, such a technique requires a more acidic medium (about pH 4-5) and lower temperatures -- about 145 deg F (63 deg C) is optimum. Though the weights and temperatures differ, the same sequence is followed as discussed in "Conversion With Alpha Amylase Enzyme".

(One way to speed up the cooking process is with steam, which -- at 350 deg F, 177 deg C -- reduces the cooking time to one minute. Another commercial approach is to use extruders: machines much like meat grinders that compress, grind, and convert the grain in a one-step process.)

FERMENTATION

If you use barley malt for the conversion process -- or if you are following some alternative recipe that does not employ Alpha Amylase Enzyme -- you will still need to add yeast.

Mix up two ounces of distiller's or baker's yeast in a quart or two of the liquid mash, and add the concoction to the wort. Vigorous agitation will oxygenate the mixture and encourage a rapid initial growth of the yeast culture.

Yeast plants can propagate in a solution with or without air, so agitate only enough to saturate the wort with air and then let it stand still. If the mash is continually agitated, the yeast will reproduce faster and make less waste: carbon dioxide and alcohol. But if the solution becomes anaerobic (without air) the yeast slows down reproduction and makes more alcohol and carbon dioxide.

Yeast also produces enzymes of its own to convert complex sugars. Since sugar conversion and alcohol conversion can take place simultaneously, the amylase enzymes and the yeast work in cooperation to convert the dextrins to glucose and fructose and then to alcohol and C02.

Fermentation is a chemical process and produces heat. In concentrated or particularly large mashes, the temperature can actually rise to levels dangerous to yeast. Since the ideal temperature for yeast is around 85 deg F, it's best to maintain that temperature by either utilizing cooling coils or keeping the water-to-grain ratio at about 40 gallons per bushel.

Conversion of sugars to alcohol and C02 will be completed in three to five days, depending on the temperature of the mixture and the type of yeast used. You can tell when the mash is done by watching the "cap" of solids on top of the solution. During fermentation, the rising C02 keeps the solids in constant motion, but when the bubbling stops, the solids fall to the bottom. At this time, you're ready to separate the solids from the liquids and begin distillation.

KEEP IT CLEAN!

Remember, sanitation is extremely important! There are many kinds of invading bacteria, including strains which can withstand boiling temperatures. So, observe the same standards that any restaurant or kitchen follows. And keep the fermenting vat well covered: a fly in the ointment will turn your mash into something that it's best to keep upwind of.

More On Conversion and Fermentation

Acid hydrolysis of starch is accomplished by directly contacting starch with dilute acid to break the polymer bonds. This process hydrolyzes the starch very rapidly at cooking temperatures and reduces the time needed for cooking. Since the resulting pH is lower than desired for fermentation, it may be increased after fermentation is complete by neutralizing some of the acid with either powdered limestone or ammonium hydroxide. It also may be desirable to add a small amount of glucoamylase enzyme after pH correction in order to convert the remaining dextrins.

High-temperature versus low-temperature cooking. Grain must be cooked to rupture the starch granules and to make the starch accessible to the hydrolysis agent. Cooking time and temperature are related in an inverse ratio: high temperatures shorten cooking time. Industry practice is to heat the meal-water mixture by injecting steam directly rather than by heat transfer through the wall of the vessel. The latter procedure runs the risk of causing the meal to stick to the wall; the subsequent scorching or burning would necessitate a shutdown to clean the surface.

High-temperature cooking implies a high-pressure boiler. Because regulations may require an operator in constant attendance for a high-pressure boiler operation, the actual production gain attributable to the high temperature must be weighed against the cost of the operator. If there are other supporting rationale for having the operator, the entire cost does not have to be offset by the production gain.

Continuous versus batch processes. Cooking can be accomplished with continuous or batch processes. Batch cooking can be done in the fermenter itself or in a separate vessel. When cooking is done in the fermenter, less pumping is needed and the fermenter is automatically sterilized before fermenting each batch. There is one less vessel, but the fermenters are slightly larger than those used when cooking is done in a separate vessel. It is necessary to have cooling coils and an agitator in each fermenter.

If cooking is done in a separate vessel, there are advantages to selecting a continuous cooker. The continuous cooker is smaller than the fermenter, and continuous cooking and hydrolysis lend themselves very well to automatic, unattended operation. Energy consumption is less because it is easier to use counter flow heat exchangers to heat the water for mixing the meal while cooling the cooked meal. The load on the boiler with a continuous cooker is constant. Constant boiler load can be achieved with a batch cooker by having a separate vessel for preheating the water, but this increases the cost when using enzymes.

Continuous cooking offers a high-speed, high-yield choice that does not require constant attention. Cooking at atmospheric pressure with a temperature a little over 200 deg F (93 deg C) yields a good conversion ratio of starch to sugar, and no high-pressure piping or pumps are required.

Separation versus nonseparation of nonfermentable solids. The hydrolyzed mash contains solids and dissolved proteins as well as sugar. There are some advantages to separating the solids before fermenting the mash, and such a step is necessary for continuous fermentation.

Batch fermentation requires separation of the solids if the yeast is to be recycled. If the solids are separated at this point, the beer column will require cleaning much less frequently, thus increasing the feasibility of a packed beer column

rather than plates. The sugars that cling to the solids are removed with the solids. If not recovered, the sugar contained on the solids would represent a loss of 20%o of the ethanol. Washing the solids with the mash water is a way of recovering most of the sugar.

Continuous fermentation. The advantage of continuous fermentation of clarified beer is the ability to use high concentrations of yeast (this is possible because the yeast does not leave the fermenter). The high concentration of yeast results in rapid fermentation and, correspondingly, a smaller fermenter can be used. However, infection with undesired micro-organisms can be troublesome because large volumes of mash can be ruined before the problem becomes apparent.

How do you measure your alcohol content?

You need a hydrometer: you need to measure how strong your mash is before you run the still. You can expect 5 or 6% alcohol in beer made from grain, but various high sugar content sources like grapes, plums, and molasses can yield 14% alcohol or higher. So test with a hydrometer to see if the fermentation batch is done.

Also, you need to test the high proof alcohol after it comes out of the still (and has cooled down to room temperature) to see the proof.

Look at the hydrometer: it reads from 0% - 100% alcohol by volume and also by proof. Alcohol volume is exactly half of the proof. A 180 proof batch of fuel is 90% alcohol by volume.

Making Ethanol from: Potato Waste

Ethanol can also be made from the waste at potato processing plants. The J.R. Simplot Company has fermented potato waste into fuel grade ethanol at two plants in Idaho for many years. These plants are small, but their design is similar to those of drymill corn ethanol plants. Basically, the process is as follows:

1) The potato waste is ground into small particles, heated and pH adjusted.

2) That slurry is then treated with several enzymes. The first reduces starch to dextrins. The mash is cooled and treated with a second enzyme to reduce the dextrins to sugar.

3) The sugars are then fermented by yeast into alcohol.

4) The alcohol is then distilled to remove water.

5) The ethanol is then dehydrated, denatured and sold.

6) The byproduct is further processed to reduce water content and is sold as an animal feed.

A typical yield from corn is about 4.2 gallons (17 litres) per cwt (100 lbs, or 45.45 kg). In contrast, potato waste from french fry processing plants yields about ½ gallon of ethanol per cwt. Whole potatoes may yield slightly more than 1 gallon per cwt. Yield is the function of starch content of the feedstock used in ethanol production.

It is believed that a similar process would work using cassava or sweet potatoes as a feedstock, although those feedstocks contain more fiber, which would most likely necessitate the use of additional enzymes, such as cellulase, to reduce the viscosity of the mash.



There are 4 different types of kettles here = 4 of 5 stages of brewing

How Heineken brews beer:

The above photo shows the main brewing room of the original Heineken Brewery in downtown Amsterdam. It is no longer used for brewing, but rather is now a high-tech visitor's center. It is quite an interesting place to visit, if you are in Amsterdam and have a couple of hours for a fun tour, followed by some product sampling in the tap room at the end of the tour.

First, they sprout some barley grains to activate the natural enzymes in the grain. Once the new little roots are about 2 cm long, this grain is then dried and ground into powder. This is then known as barley malt, rich in enzymes which help break the starches into simple sugars, which is what the yeast likes. The malt is added to the mash (cooked barley and water) early in the brewing process, while it is cooling down, and before yeast is added. The first kettle, in this photo, is the cooker kettle. It is smaller than the others, as they heat the whole batch by heating only a portion of it and then pump the hot liquid back into the first brewing kettle. This is batch cooking. Then it is pumped from the second tank into the third for gradual cooling, where they then add the malt and finally their Type A yeast. This tank is also very closely monitored for temperature and contact time with the malt and yeast, then it is pumped into a fermentation tank, where the hops are added for flavoring. There are four fermentation tanks, all fed by the first three tanks. When fermentation is finished, there is a huge sieve at the bottom of these tanks so the solids are filtered out, and the beer is drained into a large clarifying tank below this room, so any other tiny particles can settle out before bottling.

This plant is quite beautiful in terms of the size and quality of equipment, as well as simplicity of processing. The only difference in brewing so you can make your own fuel is that it is a whole lot smaller, and you don't need to add the hops for flavoring.

Batch fermentation.

Relatively short fermentation time are attained in this continuous process by using high concentrations of yeast in batch fermentation. The high yeast concentrations are economically feasible because the yeast is recycled. Batch fermentations of un-clarified mash are routinely accomplished in less than 30 hours. High conversion efficiency is attained as sugar is converted to 10%-alcohol beer without yeast recycle. Further reductions in fermentation require very large quantities of yeast. The increases attained in ethanol production must be weighed against the additional costs of the equipment and time to culture large yeast populations for inoculation.

Specifications of your fermentation tank.

The configuration of the fermentation tank has very little influence on system performance. In general, the proportions of the tank should not be extreme. The primary consideration is that you want to be able to keep this tank warm, so it should be insulated.

Commonly, tanks are upright cylinders (oil drums) with the height somewhat greater than the diameter. The bottom may be flat (but sloped for drainage) or conical. The construction materials may be carbon steel (commonplace), stainless steel, copper, wood, fiberglass, reinforced plastic, or concrete coated on the inside with sprayed-on vinyl. Usually, the tanks are covered to permit collection of the C02 evolved during fermentation so that the ethanol which evaporates with it can be recovered. This can be accomplished with a simple kitchen U-trap drain pipe, plumbed via reducer fittings to the top 2 inch threaded fitting. Fill the trap with water, and the CO2 gases will bubble out through the water and no flies can get into you precious mash.

Feedstocks:

Many potential feedstocks are characterized by relatively large amounts of fibrous material. Fermentation of sugar-rich material such as sugar beets, sweet sorghum, Jerusalem artichokes, and sugarcane as chips is not a demonstrated technology and it has many inherent problems. Typically, the weight of the nonfermentable solids is equal to or somewhat greater than the weight of fermentable material. This is in contrast to grain mashes which contain roughly twice as much fermentable material as non-fermentable material in the mash. The volume occupied by the non-fermentable solids reduces the effective capacity of the fermenter. This means that larger fermenters must be constructed to equal the production rates from grain fermenters. Furthermore, the high volume of non-fermentable material limits sugar concentrations and, hence, the beer produced is generally lower in concentration (6% versus 10%) than that obtained from grain mashes. This fact increases the energy spent in distillation.

Since the non-fermentable solid chips are of larger size, they will clog up the steam line between your cooker and the distillation column. It is necessary to separate the solids from the beer after fermentation because of the potential for plugging the still. The separation can be easily accomplished, but a significant proportion of the ethanol (about 20%) would be carried away by the dewatering solids.

If recovery is attempted by "washing out," the ethanol will be much more dilute than the beer. Since much less water is added to these feedstocks than to grain (the feedstock contains large amounts of water), only part of the dilute ethanol solution from the washing out can be recycled through the fermenter. The rest would be mixed with the beer, reducing the concentration of ethanol in the beer which, in turn, increases the energy required for distillation.

Another approach is to evaporate the ethanol from the residue. By indirectly heating the residue, the resulting ethanol-water vapor mixture can be introduced into the beer column at the appropriate point. This results in a slight increase in energy consumption for distillation.

The fermenter for high-bulk feedstocks differs somewhat from that used for mash. The large volume of insoluble residue increases the demands on the removal pump and pipe plugging is more probable. Agitators must be sized to be self-cleaning and must prevent massive settling. High-speed and high-power agitators must be used to accomplish this.

The equipment for separating the fibrous residue from the beer when fermenting sugar crops could be used also to clarify the grain mash prior to fermentation. This would make possible yeast recycling in batch fermentation of grain.

Temperature control.

Since there is some heat generated during fermentation, care must be taken to ensure that the temperature does not rise too high and kill the yeast. In fermenters the size of those for on-farm plants, the heat loss through the metal fermenter walls is sufficient to keep the temperature from rising too high when the outside air is cooler than the fermenter. Active cooling must be provided during the periods when the temperature differential cannot remove the heat that is generated. The maximum heat generation and heat loss must be estimated for the particular fermenter to assure that water cooling provisions are adequate.

Fermentation Addendum

The optimum fermentation conditions are a temperature of 86 deg F (30 deg C) and a pH of 4 to 5. When the grains are left in the sweet wort or when backset is utilized, a buffering capacity is added that assists in maintaining the required pH (acidity). The expected alcohol yield from a 15-25% solution of fermentable sugars is 6.75 to 11.25% by weight.

The time required to complete the fermentation is dependent upon the strain of yeast used. A variety of yeasts were tested for molasses fermentation in order to find a yeast strain that is highly efficient under variable conditions. (A group of 12 so tested is listed in the table below.) The ATCC 4132 produced 93 to 95% of the theoretical yield of alcohol from molasses without molasses pre-treatment. The remainder of the yeasts were less efficient in alcohol production with the 48-hour fermentation efficiency ranging down to 35% (Heinz, September 11, 1979).

Whatever feed stock you now use, and ferment with Temperature Tolerant Turbo Yeast will improve your fermentation! Whatever pH you currently ferment in, Temperature Tolerant Turbo Yeast will ferment to and it have it’s general best performance between pH 4 and 5.5.

ATCC -- American Type Culture Collection
DADY -- Universal Foods Corporation
BAKER -- Local procurement

NCYC -- National Collection of Yeast Culture, Brewing Research Foundation, England.

For small-scale production, the most readily available yeast is active dry yeast especially designed for distillers' use in grain mash fermentation. This product has been found to work well for beet, cane, and citrus molasses fermentation. The yeast is designed to produce uniform, rapid fermentation and maximum alcohol yields under a wide range of temperatures and pH. The time required for fermentation will vary with the temperature, although most estimates are for 48 to 72 hours.

Yields of alcohol may be reduced if there is any contamination of the sweet wort. Contamination with undesirable micro-organisms will decrease the yield of alcohol as these will compete with the yeast for the sugar. Prior to the addition of the yeast, contamination from external sources or from the equipment itself may occur readily in the cooling of the sugar mixture.

At this point in the process, the sugar solution is a suitable medium for growing a variety of microbes that may be pathogenic or produce toxic substances (Crombie, 1979). Microbes may be introduced with the raw materials initially, via the addition of cooling water, or from the air; thus, provision needs to be made for high-quality water, and the design must incorporate some protection from possible contamination from the air.

Fortunately the contamination problem is mitigated by the fact that yeast populations grow quite rapidly, and overwhelm many of the potentially competing organisms. In addition, the initial inoculation introduces a large yeast population that allows the yeast a head start. Provided care is exercised and, thus, unwanted microbial action does not occur, decreases in the yield of ethanol resulting from competing reactions can be held to a minimum.

Undesirable microbial reactions occurring in the fermentation step may produce unwanted substances in the stillage, but since these cannot be predicted in advance and would be batch-specific, they would need to be handled on an individual batch basis.

The solution to the contamination problem involves the design of the production facility and the training of the process operator. The plant must be designed in such a fashion that sanitation is readily accomplished and contamination of the sweet wort may be avoided when reasonable care is exercised. Once the operating procedures for a plant are established, these problems should be minimal.

All equipment currently being marketed utilizes a batch fermentation process; however, continuous fermentation units have been used in some industrial

applications. A continuous fermentation process allows the use of smaller fermenters and supplementary equipment; it has been of interest for many years.

Continuous fermentation methods have been used successfully on waste sulfite liquor in Europe. Since sulfite liquors are sterile and even antiseptic, continuous fermentation is possible and desirable.

With fermentable substances such as molasses, however, any contamination is cumulative and soon spreads throughout the system to reduce yields. The contamination can be controlled to some extent using penicillin or other antibiotics, but their use to control organisms competing for sugars and decreasing alcohol yields creates another problem: the use of by-product feed. The antibiotic content of feeds for livestock is carefully controlled by the Food and Drug Administration. FDA requires tests to show that antibiotics and their degradation products in the resulting by-product feeds are below the maximum allowable levels. Most of these antibiotics are destroyed in the drying process. One commercial ethanol producer looked at and experimented with a continuous process, but finally gave up because of the contamination problems involved.

However, continuous fermentation could conceivably work well if the fermentable solution could be sterilized. But with grains or cellulose feedstocks, the grain particles and fiber present in the sweet wort make such sterilization extremely difficult.

Although continuous fermentation offers a more rapid method of producing ethanol with smaller tanks, etc., problems remain to be worked out before the system is feasible for the small-scale operator using grains as a feedstock. Work is underway at the present time to develop continuous automated equipment for small-scale ethanol production.

If wheat is used as the feedstock, special provisions must be made for the additional foaming that occurs during fermentation because of the presence of the gluten protein. Three possibilities exist to handle this problem: increasing the capacity of the equipment over that for the same quantities of corn; using a defoaming agent; or removing the gluten protein prior to the fermentation process.

Since the fermentation process produces heat and the optimum fermentation temperature is about 90 deg F (32 deg C), cooling is necessary in order for the yeast to survive and work efficiently. The formation of ethanol is accompanied by approximately 287 kilocalories per kilogram of ethanol produced: 517 BTU per pound or 3,418 BTU per gallon (Alfa-Laval, undated). If insufficient cooling is provided, the fermentation times are increased. Where no provision is made for removal of the heat of fermentation, heat losses may occur in both of these ways: [1] from the evolution of carbon dioxide, and [2] from convection and radiation from the walls and other surfaces of the fermenter vessel. Heat removal in the

off-gas is relatively small, even though the gas is saturated with water vapor and its attendant evaporative cooling effect. If heat evolution is too great to be dissipated by radiation, the increasing temperature of the contents results in a decreased yeast activity and a greater heat release.

Ethanol Vehicle Challenge



The Ethanol Vehicle Challenge, a three-year vehicle design competition, began in 1998. It gives students real-world engineering experience as they convert new vehicles built for gasoline into optimized vehicles fuelled solely by E-85 (a blend of 85% denatured ethanol and 15% gasoline-like hydrocarbon primer). The goal is an ethanol-fuelled vehicle with greater fuel economy and lower exhaust emissions, but with the drivability, performance, and consumer appeal of a conventional gasoline vehicle.

Student from universities in the United States and Canada are replacing and upgrading major engine and fuel system components for ethanol operation. As they work on their vehicles, the students solve real-life engineering problems and make complex decisions by applying creative, innovative thinking. Their solutions may someday become a part of a production ethanol-fuelled vehicle ready for use on the road.

Competition Highlights

FUEL EFFICIENCY: In 1998, eight vehicles had better fuel efficiency than the stock Malibu. Vehicles achieved the same range on one tank of ethanol as the stock Malibu achieved on one tank of gasoline. This success continued in 1999 when 11 teams achieved better fuel efficiencies than the gasoline Silverado. The winning team, University of Illinois-Chicago, demonstrated a greater-than-10% increase in fuel efficiency.

EMISSIONS TESTING: In 1998, the University of Waterloo came close to meeting California Air Resources Board Low-Emission Vehicle (LEV)

emission standards. In 1999, three teams met LEV and were within 0.020 grams of THCE per mile of meeting Ultra-Low-Emission Vehicle (ULEV) standards - impressive for a half-ton, 4x4 truck!

COLD START: The teams have demonstrated that cold-start problems, due to the lower vaporization of E-85 fuel, can be overcome. Some of the innovative cold-start technologies include an onboard distillation system, glow-plug ignited fuel system, electric supercharger, quick-heat intake manifold, a liquid-heated fuel injector rail, and a phase-changing catalyst.

PERFORMANCE: The 1999 competition vehicles outperformed the stock Silverado. Twelve vehicles out-accelerated the stock truck; Cedarville College reached 60 mph in 15.29 seconds on the quarter-mile track, beating the stock truck by 1.5 seconds. In the hill climb event, 12 vehicles outperformed the stock Silverado; the Minnesota State University at Mankato vehicle reached the top of the hill in 36.20 seconds - almost 10 seconds faster than the gasoline-powered truck.

EDUCATION: In 1999, more than 70% of the graduating seniors who participated in the EVC accepted jobs in the automotive industry. They take with them an unparalleled engineering experience as well as a direct, hands-on knowledge of ethanol as an automotive fuel.

In the final year of the competition, Ethanol Vehicle Challenge 2000, student teams will continue to optimize their ethanol-fuelled Chevrolet Silverado pickup trucks for lower emissions and greater fuel economy.

Future Truck Competition

2.7L Chrysler Sebring Convertible



This vehicle is designed to run on 85% ethanol.

DaimlerChrysler Adds Three New Flex-Fuel Vehicles

June 3, 2002 DaimlerChrysler is adding three new flexible-fuel vehicles (FFVs) to its 2003 product line. FFVs can be fueled with E85 (a blend of 85% ethanol and 15% gasoline), gasoline, or any combination of the two fuels. The new E85 models will include: Dodge Stratus Sedans with 2.7-liter 16-valve V-6 DOHC engines; Chrysler Sebring Sedans and Convertibles with 2.7-liter 16-valve V-6 DOHC engines; Dodge Cargo Minivans with 3.3-liter 16-valve V-6 SOHC engines. These new vehicles will complement DaimlerChrysler's

flexible-fuel product line and give fleets covered by Energy Policy Act of 1992 (EPAct) alternative fuel vehicle acquisition requirements more choices when selecting vehicles.

Advanced Vehicle Technology Competitions

Since 1987, the U.S. Department of Energy (DOE) has sponsored 44 different college and high school Advanced Vehicle Technology Competitions through Argonne. Argonne organizes and operates these competitions to accelerate the development and demonstration of technologies of interest to DOE and the automotive industry.

Provide the automotive industry with a new generation of engineering leaders with highly desirable experience.

Help prepare the market to accept advanced vehicle technologies.

The UC Davis Future Truck 2002 team built a truck getting 30 miles per gallon or better on ethanol, reducing emissions by 67%, and able to accelerate from 0-60 mpg in only 7 seconds.

http://www.team-fate.net/index.html



Participants at FutureTruck 2000

Focusing on engineering students at the graduate and undergraduate levels, these competitions target ultra-efficient vehicle designs, hybrid electric vehicles, and alternative-fuel vehicles for development, demonstration, and testing. They emphasize current or future vehicle technology; students work with production vehicles (donated by vehicle manufacturers) to improve their energy efficiency and to meet the toughest emissions standards while maintaining performance and functionality. Extensive data are collected to measure the real-world performance of advanced technologies and benchmark their developmental status.

The competitions represent a unique coalition of government and industry aimed at eliminating technical and institutional barriers to acceptance of advanced vehicle technologies and alternative fuels. The competitions are highly valued

and supported by automotive manufacturers, suppliers, fuel providers, and the educational community. Auto industry experts judge events, interact with students, and compare technologies. Federal funding for the competitions is heavily leveraged by industry contributions.

RESULTS

Conducting competitions provides significant technical, educational, and promotional benefits to DOE and the nation. More than 15,000 student engineers from more than 235 schools from the United States, Canada, and Mexico have participated.

The premier competition, FutureTruck, provides a way for engineering schools to participate in hands-on research and development with leading-edge automotive propulsion, fuels, materials, and emissions control technologies. The objectives of the competition are to explore and refine production-feasible advanced propulsion technologies that improve the efficiency of sport utility vehicles. At the same time, hundreds of the country's best young engineers are gaining invaluable experience developing and implementing the latest automotive technologies.

Several innovations and ongoing research projects have resulted from the competitions. Examples include the following:

In FutureTruck 2000, a 13% improvement was attained in on-road fuel efficiency (MPGE), and a 26% reduction was attained in greenhouse gas emissions, compared to the stock Chevrolet Suburban.

In Ethanol Vehicle Challenge 2000, the winning vehicle in the emissions event (University of Illinois at Chicago) met the California Air Resources Board ultra-low emissions vehicle standard - one of the toughest in the world. Northwestern University developed a gas quality sensor, Old Dominion University developed a gaseous fuel injector that is now an OEM component, and other teams developed several complex emission-control systems.

Four universities were awarded $1.2 million in research grants on the basis of their competition experience.

Three university hybrid electric vehicles were used to help validate the draft Society of Automotive Engineers Hybrid Electric Vehicle Emissions Procedures. More than 250 student papers and over 20 Argonne technical papers have been published.

Future Plans

The competitions continue to grow in sophistication and complexity. New competitions based on ethanol reformation to hydrogen for use in fuel cell vehicles are under discussion. Both Ford and General Motors have made a commitment to long-term support for these competitions on the basis of their benefits in technology development and demonstration.

How Much Energy Does It Take to Make a Gallon of Ethanol?



USDA REPORT: ETHANOL HAS LARGE, GROWING POSITIVE ENERGY BALANCE

Ethanol Provides More Than 6 Btus of Energy for 1 Btu of Liquid Fuels Used

Washington, DC - The U.S. Department of Agriculture (USDA) today released its new study of the energy efficiency of ethanol production. The report, "The Energy Balance of Corn Ethanol: An Update," concludes that ethanol production yields 34% more energy than is used in growing and harvesting grain and distilling it into ethanol. The report can be accessed on USDA's web site at: www.usda.gov/oce/oepnu/aer-813.pdf.

The study cites increased corn yields, lower energy use in the fertilizer industry, and advances in fuel conversion technologies that have enhanced the economic and technical feasibility of producing ethanol. The study is an update of a previous USDA study completed in 1995, which demonstrated a 24% net energy gain.

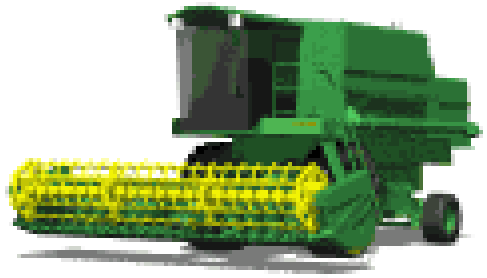
In addition to providing a 34% positive energy gain, ethanol production utilizes mainly domestically available energy, such as coal and natural gas. Therefore for every 1 Btu of liquid fuel used to produce ethanol, there is a 6.34 Btu output.

RFA president Bob Dinneen made the following statement concerning the report:

The new USDA energy balance study concludes that ethanol has a positive energy balance, that its growing, and that it will continue to improve in the future. But that's hardly surprising. Literally every organization conducting an energy balance study of ethanol over the past decade has concluded the very same thing -with one exception.

With a positive energy balance, ethanol is clearly the premier environmental liquid transportation fuel - harnessing the power of the sun and reducing greenhouse gas emissions. And by displacing over 6 Btus of liquid fuels for every Btu used during its production, ethanol clearly helps reduce our dependence on foreign oil. As a domestic fuel using U.S. grain as a feedstock, ethanol boosts the U.S. economy - especially in rural America.

Only Dr. Pimentel disagrees with this analysis. But his outdated work has been refuted by experts from entities as diverse as the USDA, DOE, Argonne National Laboratory, Michigan State University, and the Colorado School of Mines. While the opponents of ethanol will no doubt continue to peddle Pimentels baseless charges, they are absolutely without credibility.



Institute for Local-Self Reliance (ILSR),
August, 1995

One of the most controversial issues relating to ethanol is the question of what

environmentalists call the "net energy" of ethanol production. Simply put, is more energy used to grow and process the raw material into ethanol than is contained in the ethanol itself?

In 1992, ILSR addressed this question. Our report, based on actual energy consumption data from farmers and ethanol plant operators, was widely disseminated and its methodology has been imitated by a number of other researchers. This paper updates the data in that original report and addresses some of the concerns that some reviewers of the original report expressed.

Our analysis again concludes that the production of ethanol from corn is a positive net energy generator. Indeed, the numbers look even more attractive now than they did in 1992. More energy is contained in the ethanol and the other by-products of corn processing than is used to grow the corn and convert it into ethanol and by-products. If corn farmers use state-of-the-art, energy efficient farming techniques and ethanol plants integrate state-of-the-art production processes, then the amount of energy contained in a gallon of ethanol and the other by-products is more than twice the energy used to grow the corn and convert it into ethanol.

As the ethanol industry expands, it may increasingly rely on more abundant and potentially lower-cost cellulosic crops (i.e. fast growing trees, grasses, etc.). When that occurs, the net energy of producing ethanol will become even more attractive.

Three subordinate questions must be addressed to estimate the energy inputs and outputs involved in making ethanol.
1. How much energy is used to grow the raw material?
2. How much energy is used to manufacture the ethanol?
3. How do we allocate the energy used in steps one and two between ethanol and the other co-products produced from the raw material?

Energy inputs and outputs in this report are on a high heat value basis.
Energy Used to Make Ethanol From Corn and Cellulose (Btus per Gallon of Ethanol)
Corn Ethanol (Industry Average)
Cellulosic Crop-Based Ethanol

Net Energy Gain 123,407
Percent Gain 162%

Commercial Alcohols Inc.



Fuel Ethanol and Industrial Alcohols Production

The modern motor fuel grade ethanol industry is only 18 years old. Early plants were very inefficient. Indeed, in 1980 a typical ethanol plant all by itself consumed more energy than was contained in a gallon of ethanol. Some plants used as much as 120,000 BTUs to produce a gallon of ethanol that contained only 84,100 BTUs of energy.

In the last decade many ethanol plants have become much more energy efficient. In 1980, for example, ethanol plants used 2.5 to 4.0 kWh of electricity per gallon of ethanol produced. Today they use as little as 0.6 kWh. The majority of ethanol producers still purchase electricity from outside sources, but newer facilities generate electricity from process steam within the plant.

In the late 1970s, ethanol plants did not recover waste heat. Today they do. Old energy intensive rectification and solvent extraction systems required 12,000 BTUs per gallon of ethanol produced. Newer molecular sieves need only 500 BTUs.11
Larger producers have been using molecular sieves for several years. Now smaller plants (20 million gallons per year and less) are starting to incorporate them.

Best-existing and state-of-the-art ethanol plants can achieve energy reductions through a combination of these technological innovations. Molecular sieves reduce distillation energy significantly; low cost cogeneration facilities produce process steam and electricity; and semi-permeable membranes efficiently remove co-products from the process water to reduce the energy requirements of drying.

Wet mills, which account for 63 percent of all ethanol currently produced, extract higher value co-products than dry mills. Co-products from wet mills include corn oil, 21 percent protein feed, 60 percent gluten meal, germ, and several grades of refined starches and corn sweeteners. In dry milling, co-products can include corn oil and distillers dry grain with solubles (DDGS), which is used as animal

feed. Carbon dioxide is a fermentation by-product of both milling processes.

Dry mills derive the DDGS co-product from the process water after fermentation occurs. It then requires a significant amount of energy to dry this co-product into a saleable form. Wet mills derive the majority of the co-products before fermentation through mechanical separators, centrifuges, and screens. All told, wet mills require 60 percent more electrical energy than dry mills on average, while requiring 10 percent less thermal energy. These differences are related specifically to the processing of the co-products, and are illustrated in the "Average" column in Table 3.

An integrated, relatively small-scale dry mill could avoid drying energy requirements for co-products. Reeve Agri-Energy in Garden City, Kansas, operates a 10 million gallon per year plant that feeds wet DDGS to its cattle. This operation uses only about 33,000 BTUs to produce a gallon of ethanol. However, a limited number of locations exist with a sufficient number of nearby livestock to justify such an operation, and it would probably not be economical for larger dry milling operations to adopt such practices.

A wider number of wet mills, on the other hand, may be able to achieve the energy use levels noted in the best existing wet mill category in Table 3.

We conclude that the ethanol industry, on average, uses 53,956 BTUs per gallon to manufacture ethanol. The best existing plants use 37,883 BTUs per gallon. Next generation plants will require only 33,183 BTUs per gallon of ethanol produced.

3. How do we divide the energy used among the products produced?

If we add the amount of energy currently used in growing corn on the average farm to the amount of energy used to make ethanol in the average processing plant today, the total is 81,090 BTUs per gallon (Table 1, Column 1). Under the best-existing practices, the amount of energy used to grow the corn and convert it into ethanol is 57,504 BTUs per gallon. Ethanol itself contains 84,100 BTUs per gallon. Thus even without taking into account the energy used to make co-products, ethanol is a net energy generator.

But an analysis that excludes co-product energy credits is inappropriate. The same energy used to grow the corn and much of the energy used to process the corn into ethanol is used to make other products as well. Consequently, we need to allocate the energy used in the cultivation and production process over a variety of products. This can be done in several ways.

One is by taking the actual energy content of the co-products to estimate the energy credit. For example, 21 percent protein feed has a calorie content of

16,388 BTUs per pound. The problem with this method is that it puts a fuel value on what is a food and thus undermines the true value of the product.

Another way to assign an energy value to co-products is based on their market value. This is done by adding up the market value, in dollars, of all the products from corn processing, including ethanol, and then allocating energy credits based on each product's proportion of the total market value. For example, Table 4 shows the material balance and energy allocation based on market value for a typical wet milling process. Here the various co-products account for 43 percent of the total value derived from a bushel of corn, and thus are given an energy credit of 36,261 BTUs per gallon of ethanol. Assuming an average efficiency corn farm and an average efficiency ethanol plant, the total energy used in growing the corn and processing it into ethanol and other products is 81,090 BTUs. Ethanol contains 84,100 BTUs per gallon and the replacement energy value for the other co-products is 27,579 BTUs. Thus, the total energy output is 111,679 BTUs and the net energy gain is 30,589 BTUs for an energy output-input ratio of 1.38:1.

In best-existing operations, assuming the corn is grown on the most energy efficient farms and the ethanol is produced in the most energy efficient plants, the net energy gain would be almost 58,000 BTUs for a net energy ratio of 2.09:1. Assuming state-of-the-art practices, the net energy ratio could be as much as 2.51:1. Cellulosic crops, based on current data, would have a net energy ratio of 2.62:1.

There are circumstances where ethanol production would not generate a positive energy balance. For example, one could assume corn raised by the least energy efficient farmers, those who use continuous corn planting and irrigation, being processed by ethanol plants that do not use cogeneration and other energy efficient processes. In this case ethanol production could have a negative energy balance of about 0.7:1. However, a relatively small amount of ethanol is produced in this manner, possibly less than 5 percent. We think it reasonable to look at least to columns one and two for the answer to our initial question. Based on industry averages, far less energy is used to grow corn and make ethanol than is contained in the ethanol. Moreover, we think it is a safe assumption that as the ethanol market expands, new facilities will tend to incorporate state-of-the-art processing technologies and techniques so that each new plant is more energy efficient than the one before. It is less certain that farmers will continue to become more energy efficient in their operations because of the many variables involved. Nevertheless, it does appear that growing numbers of farmers are reducing their farm inputs and that this trend will continue.

A final word about cellulose. If annual ethanol sales expand beyond 2 billion gallons, cellulosic crops, not starch, will probably become the feedstock of choice. The data in the last column suggest a very large energy gain from converting cellulosic crops into ethanol. Cellulosic crops, like fast growing tree

plantations, use relatively little fertilizer and use less energy in harvesting than annual row crops. The crop itself is burned to provide energy for the manufacture of ethanol and other co-products. A major co-product of cellulosic crops is lignin, which currently is used only for fuel but which potentially has a high chemical value. Were it to be processed for chemical markets, the net energy gain would be even greater.

NOTES

1 The difference between high and low heat values represents the heat contribution of the condensation of water during combustion. When ethanol is burned, for example, it produces heat and water vapor. As the water vapor condenses it gives off additional heat. Ethanol has a low heat value (LHV) of 76,000 BTUs/gallon, an estimate which more accurately represents the heat content of the fuel in conventional combustion engines. Ethanol has a high heat value of 84,000 BTUs/gallon. In the United States the energy content of fuels conventionally is expressed on a high heat value (HHV) basis. Interestingly, in Europe LHVs are used. The use of either basis does not affect the conclusions of our analysis such as long as the same heat values are used for all inputs and outputs.

2 The estimate of the net energy gain from cellulosic crop-based ethanol is considered conservative. We believe that as this industry develops, the same learning curve that occurred in the starch based ethanol industry will occur in the cellulosic based ethanol industry, fostering a much more positive net energy gain for ethanol production from cellulose.

3 Agriculture Chemical Usage: Field Crops Summary. U.S. Department of Agriculture. Economic Research Service. Washington, D.C. 1992-1994.

4 Bosch, D. J., K. O. Fuglie, and R. W. Keim, Economic and Environmental Effects of Nitrogen Testing for Fertilizer Management, U.S. Department of Agriculture, Economic Research Service, 1994.

5 Alternative Agriculture. Committee on the Role of Alternative Farming Methods in Modern Production Agriculture. Board on Agriculture. National Research Council. National Academy Press. Washington, D.C. 1989.

6 Research conducted by the Department of Agricultural Economics. University of Missouri-Columbia, Columbia, Missouri.

7 Testing indicates that one acre of corn absorbs approximately 90 lbs of nitrogen fertilizer in one growing season. All of the estimates for fertilizer usage in this report assume synthetic fertilizer inputs. The difference between corn's nitrogen requirements and the fertilizer requirements indicated represent the

reductions possible via the alternative growing strategies mentioned specifically in the text. These include rotations with leguminous crops, and the use of naturally occurring forms of nitrogen, such as animal waste.

8 Previous studies have included other components in the on-farm analysis. One included the amount of solar energy used in photosynthesis. Another included the embodied energy of farm machinery, that is, the energy used to make the machinery. We have decided not to include energy inputs which are acquired at no cost, like sunlight. Also we have not included embodied energy because the estimates are subject to a very high degree of uncertainty.

9 Personal conversation with Richard Thompson, November, 1992.

10 About 95 percent of the motor fuel grade ethanol in the United States is produced from 10 million gallon per year facilities or larger. Although there are a number of facilities of smaller scale, the vast majority of those will quickly expand production, if commercially successful.

Our conclusion is that under the vast majority of conditions, the amount of energy contained in ethanol is significantly greater than the amount of energy used to make ethanol, even if the raw material used is corn.

Gasohol, E-85, and pure alcohol vs. "Make your own"

Hot cars run better on hot fuel!



More power, and still getting 24 miles per gallon at 80

mph!

If you want to use your home-made ethanol in your car as E-85 (85% ethanol and 15% gasoline, before you mix it with gasoline, it has to be 100% pure: 200 proof. But even though the Charles 803 still will make 194 proof, again and again, you can never remove that last 3% of water using a still of any kind. You will need to use a molecular sieve. This sounds technical, but it is real easy. Just read this letter I got from Dr. Grant Carlson with Eco-Rebuilders. "Since we remanufacture old third generation Corvettes with big horsepower-high compression-fuel injected engines, homemade E85 is important to our customers. A molecular sieve is just zeolite: link to information about the manufacturer we use is shown here. 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 5lbs 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. http://www.thomasregister.com/olc/adcoa/molecula.htm

The basic dilemma for converting engines over to a new fuel is like the question, Which came first, the chicken or the egg?

If you convert your car to run only on alcohol, where will you buy it when you run out? When will anyone supply alcohol fuel if there aren't any cars converted to run on it?

In 1980, Brazil neatly solved both problems at once, along with their problem of really low prices on the world sugar market. So the military government declared that the countries sugar cane production would go into making alcohol for fuel, and the car manufacturing companies in Brazil will have to make cars that run on alcohol.

The result? Twenty years later, alcohol fuel is much cheaper and much more available than petrol. When you rent a car at the airport, you have a choice between clean and cheap ethanol or a dirty and more expensive petrol fueled car. Ethanol will cost you about $2.50/gallon, while gasoline will cost $4.20/gallon.
Because of the successful and widespread use of alcohol fuel in Brazil, most manufacturers now make cars that are fuel injected, and this is controlled by a computer chip that can be changed out to make it into an FFV (flexible fuel vehicle.

High proof still with automatic control valve



Controlling temperature is the key to consistent high proof.

How to Make 200 Proof:

Corn grits, the laboratory process:

To make 200 proof, you first make yourself some 180 to 190 proof, and you can make 190 proof (95% ethanol) successfully, time after time with the Charles 803 still. See Principles of Operation.

Now here is one way to get out that last 5% of water, which cannot be done with a still. (Warning, this is a bit technical: the Zeolyte process described higher up on this page is much, much easier).

If there's ethanol in the gas you buy at your local filling station, there's a slight chance that it was filtered through corn grits, using a technique developed at Purdue University. When the corn grits get saturated with water you just make more ethanol out of them! Drying of ethanol refers to the process of removing the last 5 or 10% of water, in order to make anhydrous, or "neat" alcohol.

Ladisch and his students at Purdue University found that drying of ethanol vapors saved energy and was economic. The corn industry makes ethanol by fermentation and has lots of corn grits readily available. Passing the wet vapors through a filter bed of corn grits or other drying agents removes most of the water to yield a product that is close enough to absolute ethanol. When the drying agent approaches exhaustion, it is regenerated by heating and reused. Eventually the drying agent breaks down but has potential uses elsewhere in corn processing.

Source: Mike Ladisch; ladisch@ecn.purdue.edu

Octane, fuel mixes, and 180 proof:

180 proof ethanol is considered to be rated at about 105 octane. Anhydrous alcohol, is around 110 octane, which is why only a small amount, about 10%, has to be mixed with gasoline to increase the rating. The Indianapolis 500 race in May of every year has used straight ethanol as their primary racing fuels for over 80 years, and this is still the case. Alcohol has a lot of power, and it burns cooler, which is really great for a race car, since heat is a big enemy of engines, along with friction. The only danger of alcohol as a racing fuel is that when there is a big car wreck, the flames are pretty much invisible, so a driver can be on fire and no one will see it. Of course, now they all wear non-flammable jumpsuits. My point, however, is that in the racing industry, ethanol has a long history of being the preferred fuel. The guy who helped us teach the car conversion class used to say, "I just want to learn to make my own ethanol because I like to race cars, and the stuff is expensive."

Ethanol was also the fuel of choice for aviation fuel during World War II for both the Americans and the Germans.

Octane is a strange rating system, as they don't really count the number of octal hydrocarbons as they do when they name methane (4), propane (3), or butane, (C4H10). Octane would be, naturally, 8. But rather than measuring a percentage of octal hydrocarbons, octane is an index of how slowly a fuel burns. The slower, the better, so that the explosion of the fuel/oxygen mixture can push the piston down rather than slam it down. That is what happens when you use too low an octane fuel, say, 85 octane instead of 90, and you hear that annoying knock or pinging sound. Too make matters worse, back in the late 70's, the petrochemical boys decided to change the octane rating numbers, so that what they labeled at 90 octane was equivalent to say, 86 or 88 octane from the previous system. In other words, they changed the numbers so they could sell us a cheaper grade of gas for the same amount of money we used to pay for a higher grade.

Back in the 60's, the USA manufacturers made mostly big muscle cars, and it was common to buy big V-8 engines that had 300 horsepower, and got about 8 or 10 miles to the gallon. These engines were high compression, with compression ratios of around 12 to 1, which is perfect for ethanol. When I first started high school in 1963, and drove a motorcycle to school, gas was only $0.34 per gallon, for regular, and $0.38 for what they called ethyl or premium grade, which was 98 octane. This was first lowered so that premium was only 94 octane, and now it is only 90 or 92 octane, depending on what country you live in, while regular is only 85 to 87 octane.

The automotive industry had full advance knowledge of the changes in the octane rating system, since many member of the Board of Directors for General Motors and Ford also sat on Exxon and Union Oil Boards. So the automotive industry powered down their cars, and they advanced the timing a

bit more, to compensate for the lower grade fuel. This was back when they added lead to the petrol (which they still do in China), to reduce octane. Lead is cheaper than alcohol or MTBE, but much more hazardous to health.

In the early 80s, the US public discovered the better mileage of Japanese built cars, with their smaller engines and higher RPMs, so the US automotive industry went into a huge slump, and Toyota and Datsun (now Nissan) became one of the most popular cars in the world.

A real complete ethanol conversion, according to our racing car specialist, in addition to drilling out the carburetor jets and replacing all plastic and rubber gaskets in the carburetor with one which would not dissolve in ETOH. (Paper gaskets worked fine.) It also meant changing out the pistons for hemispherical racing pistons, and shaving the heads to reduce the cylinder volume and thus increase compression.

Later cars were manufactured to handle this lower grade fuel. The term gasohol, used throughout the USA in the early 80's, was a mix of 10% anhydrous (without water) grain alcohol. Arco (Atlantic Richfield) was one of the first to use this mix to up the octane on their petrol, and they bought a sugar cane processing plant in Louisiana and started making their own alcohol. It allowed them to eliminate the lead, hence the term, unleaded. Soon the big 5 oil companies all had ethanol distillation plants in the Southern US, and I believe they all still do. The authoritative history of ethanol production and use is to be found in back issues of Gasohol, USA, published by Charles Walters, Jr., at Box 9547 , Kansas City, Missouri, 64133. I do not know if this address still works, but it has been years since this magazine went out of business. This same publisher still publishes Acres, USA. I recently recommended this magazine to an organic farmer, and she was delighted to find that they have a whole library of books available. They may still sell a book which Charles Walters wrote on ethanol. Anyway, all of the above is but a tailgate view of automotive history from the viewpoint of an old farmer (I grew up on a dairy farm, and also kept bees for over 20 years).

In terms of lubrication, there are several manufacturers who make what they call, synthetic oil. Now, what this really is, my former contacts in the oil industry tell me, is biodiesel! It is vegetable oil which is has been converted into certain ethyl esters with the addition of 10% anhydrous grain alcohol, i.e., ethanol. Amsoil was the first to come out with this, and it sold for 5 to 6 times the price of a quart of oil, but part of the high price was due to the fact that they decided the best way to reach the market was by word of mouth, of people using this, themselves. So they started a multi-level marketing organization, like Amway, to sell it. Later, Mobil came out with Mobil One, then Castrol offered a synthetic oil, and now most oil companies have a synthetic oil which they claim can go 20,000 miles between oil changes (instead of the usual 3,000 to 5,000 miles).

I recently talked with a Porsche salesman, and their dealership sells all brand new Porches (we are talking cars in the ($70 to 80,000 price range, with a top speed of 180 miles per hour, with synthetic oil in the engine! Then they brag that these cars only need an oil change once every 15,000 miles. These cars are made to be able to sustain cruising speeds of 120 to 140 miles per hour on the German Autobahn, and the factory backs them up on this synthetic oil, so you know it is good stuff! One of the main reasons that this oil last longer is that it is less susceptible to oxidation, which is one of the things that changes the composition of regular oil. Second, it provides superior lubrication because the molecules are much smaller, thus, slipperier.

The one question I never got answered, however, is, if you drive a car on ethanol fuel, it seems to me that the synthetic oil would degrade a bit faster due to small amounts of blow-by, which is what you call it when small amounts of burning gases make it past the piston rings, going the reverse direction of where you want them to go. Ethanol is too good a solvent, sometimes. This would dilute the oil a bit more, I believe, but I do not know the overall effect of this. I always used regular 30-W or 10-30W oil, and had no problems whatsoever on the lubrication side. I just had to change my fuel filter every time I changed oil, as I picked up a bit of rust form the gas tank.

How pure do you want (or need) it?

OK, you can find a lot of discussion on the Web about making 190-proof pure grain alcohol. These discussions are mostly for home distiller enthusiasts who are only thinking in terms of making drinking alcohol. Naturally, if you are going to drink it, you want to make sure it is free from any small amounts of poisonous byproducts like methanol and fusil oils, as well as any traces of heavy metals like lead or mercury. But when you are burning it in your engine, anything that contributes to combustion should be left in, really. So there is no need to do any fine filtering, other than a paper filter like a coffee filter (for small amounts) or an in-line paper cartridge water filter for larger amounts. All you need to do is make sure there aren't any particles which could clog your carburetor or fuel injectors.

Next, in terms of proof, how high does it need to be? You are never going to make 200 proof alcohol in a still, because you always come up against a physical limitation which has to do with the concentration of vaporized ethanol molecules at a specific temperature. This is known as the azeotropic equilibrium barrier, and is beyond the scope of this article. So 190 to 192 proof is as high as you can make with any still, no matter how efficient it is. To get the last 5% of water out of the ethanol can require just as much energy as it did to get out the first 95%. But it can be filtered out through corn grits (see the link on this page) to make 100 % anhydrous alcohol.

Now, you don't need anhydrous alcohol unless you intend to mix it with gasoline (petrol). You may want to do this for the simple reason that you wouldn't have to

do very much in the way of converting your engine, as you can make your own E-85.

E-85 is, as you might guess, 85% ethanol and 15% gasoline (plus some anti-corrosion additive). This is quite different than a product sold in the 1980s, called Gasohol, which was gasoline with 10% ethanol. This name confused people, and they didn't know if they could use it or not, even though it would work in any engine. So they went over to calling it "Unleaded Premium". This is a pretty good way to extend your gas mileage and also is a pretty safe way to use alcohol as a fuel, for the simple reason that if you ever run out of your home-made gasohol, you can mix it with unleaded gasoline. Then you are back on the road again. But the only kind of alcohol which will mix with gasoline (petrol) is 100% (200 proof) ethanol. If you have any water content in your home-made ethanol, it will separate out once you mix it with petrol. Water is heavier than gasoline, so it forms a thin layer at the bottom of the fuel tank of you car, and then gets sucked up by your fuel pump and your engine will cough and die. This isn't the end of the world, as you can get it removed by adding a bit of methanol to your tank (it is sold as "Gas Dryer" or various other winterizing products at automotive parts stores).

Now for those of us who like to run on pure alcohol which has no nasty petrol mixed in with it, then 160 to 170 proof is plenty high enough. You can get great mileage on this if you do a full conversion to alcohol, but you will be out of luck if you run out of fuel, unless you make your car a duel-fuel vehicle (which many people did back in the early 1980s, by installing a duel carburetor setup.)

You do not have to try to do anything different to get your 190 proof, (95% ethanol) other than to closely monitor the temperature setting of the automatic control valve. You may have to do an elevation correction (if you are living in the mountains) to make sure you know precisely what temperature to set it at, but the overall idea is that the top area of the reflux column, just before the vapors rise into the condenser section, must be controlled at precisely 2 degrees F above the condensation point of alcohol which is 174 F. Then you have pure alcohol moving up, and the condensed water never goes any higher.

The automatic control valve I use is a thermostatic water valve, which opens on temperature rise. You will never get the precise control you require from trying to control the rate the water boils with an electric heating element. That is like cooking on an electric stove. The big problem is that the pot always boils over, right? Wouldn't you rather cook with gas? Furthermore, you are much less likely to burn your mash if you have any particulates that come out of solution in the wash, even after it has been filtered. You have sugar, therefore you have carbon. You know what it is like to clean out a blackened stainless steel cooking pot. You don't want that burned taste to get into subsequent batches, so better to cook with gas, and also better to use a reflux column like mine which can precisely control the temperature inside the reflux column on a graduated basis, so that

you have a reverse heat flow going on inside the reflux column. Trying to control temperature at the condenser section is like closing the barn door after the horses have escaped. This still design was built by myself and a group of a dozen people, including three engineers. We refined the design with four different generations of successive models. This still is as different from the tabletop pot stills as a new Lexus is from a '57 Chevy. Those early models have their charm, but to make enough to be used as a fuel, you want some serious production. Read my explanation of how this still works, in Principles of Operation, as well as the chapter on Safety and Boiler operations. People who buy my still plans will also get a chapter on How to handle high volumes of mash and fluid handling.

I have produced well over a thousand gallons of high proof alcohol in the many different stills I have built over the past twenty years. Sure, my intention was and continues to be using ethanol for fuel, but the principals are the same. I can and have produced 195 proof on my first run, it is just that when I am talking about 180 proof in my web pages, it is because this is a more efficient fuel in terms of getting more miles per gallon when you are replacing gas with homemade brew in your tank. In fact, you get better mileage than you would on gas. Also, I sell the temperature control valve for $290. I have looked for years, and haven't found anything better than what I have been using all along. You can see the valve on the left side of this photo, on the left side of this page. Also, once you buy the plans and build the still, I am happy to be available to answer all your question via email.

Rule 1: Gas and water don't mix!
Rule 2. High tuning for high performance.
Rule 3. Carry an extra can!

Water and gas don't mix.

This means you have to decide whether to convert your car to run on homemade high proof (then you are truly independent from relying on nasty and greedy oil companies like Esso/Exxon.) For the best performance, you will need to change the size of your jets in your carburetor (if you have one) or the fuel/air mix of the electronic fuel injectors. You would also want to up the compression ratio to 12 to 1 by installing racing pistons. Finally, you may need to actually install a separate fuel tank so that if you want to switch between petrol and alcohol fuel, you can do this with a bypass valve/switch, without having to drain the tank. If you have a little bit of 180 proof in the bottom of your tank and add petrol, the water in the alcohol will separate out and sink to the bottom. To get it out without draining the tank, you have to add either some 100% alcohol or better, some methanol (which is sold as a de-icer in automotive parts stores).

High tuning for high performance:

Up the compression ratio, change your fuel jets, advance your timing until it runs really smooth, and watch for cops in your rear view mirror!

Carry an extra can!

If you change over to home-made fuel, carry enough to get you home again. Henry Ford built the Model T to run on either gas or alcohol, because "There are more stills in this country than gas stations!" We used to be able to buy alcohol back in the 1920's, until Standard Oil of Pennsylvania started the "gas wars" by selling gas at $0.05/gallon for just long enough to run the "Alky sellers" out of business.

The 4 Myths about Alcohol Fuel

My basic philosophy when it comes to petroleum is, don't trust the oil companies! Now, I usually buy gas just like everyone else, but having had the freedom of being able to make my own fuel, and finding that I got great performance on it, I did a bit of digging to see what the truth was behind the myths that the oil industry was putting out.

The 4 basic myths propagated by the petrochemical industry are:

1. Ethanol doesn't have as much energy as gasoline. 86,000 BTU's vs. 126,000 BTU's.

Answer: Burning it in an open flame to boil water is not the same as burning it in an internal combustion engine. Ethanol burns slower which is better for transferring power to the piston. It is a well know fact that only 14 to 18% of the energy in gasoline is used effectively, as most of it is lost in heat, as well as some unburned emissions. I have been able to get the same mileage out of 180 proof as I did with unleaded. If you start using E-85, you will get about 10 to 15 % less mileage, but pay about 20% less per gallon of fuel. If you modify your engine to optimize it for this high octane 106-fuel, your mileage will be the same as on gasoline.

2. Ethanol takes more energy to make than you get out of it.
Not true. This is some very old propaganda. Modern commercial distilleries making 40 gallons per year each are usually only using about one-third the BTU value of the final 200 proof Ethanol product they are selling

3. Ethanol is highly corrosive. This is nothing that can't be solved with a modern understanding of coatings, gasket materials, adhesives, and fuel additives In fact, VW, GM, Ford and many other companies have made ethanol fuel cars designed to run on alcohol. The other issue is that E85, which is 85% anhydrous alcohol and 15% gasoline has corrosion inhibitors to enable this fuel to be sold on the open market (about 15 states in the midwest sell this fuel).

4. Ethanol is high in emissions.

The reverse is true. See the Clean cities website.

http://www.eere.energy.gov/vehiclesandfuels/epact/



High compression engines work best on ethanol.

Molasses: the lazy way to make your own fuel.

You can make180 proof, ethanol fuel for only $1.00/gallon, or less!

The great molasses tragedy!



Firemen try to rescue people trapped by molasses.

Now for a sobering piece of history about molasses: this is from:

http://home.nycap.rr.com/useless/molasses/molasses.html

Entitled, The Great Molasses Tragedy

"This is a story that I had heard when I was very young, but cannot place its origins. It was one of those stories that I always assumed was pure fiction until I stumbled upon it once again more than twenty years later.

"Clearly (since you can read the title above), I am talking about the Great Molasses Flood that swept through part of Boston, Massachusetts on January 15, 1919.

"At this time in history, molasses was America's primary sweetener. It was used to make all types of cookies, cakes, bread, and especially rum. "Due to its popularity at the time, there were many molasses factories, warehouses, and storage tanks lining the shores of Boston. After all, Boston was considered to be the distilling capital of the United States.

"To tell this story, we are only concerned with one of these facilities - a large storage tank located in Boston's north end - near the sites where the world famous Fanuel Hall (Quincy Market) and the New England Aquarium stand today.

"This was no small tank of molasses. The tank stood over 50 feet tall. Estimates of its capacity range from 2.2 to 2.5 million gallons!

"And we all know where this story is going. A sudden thunderous cracking sound was heard. The tank exploded and all the molasses began to flow down the city streets.

"The actual wall of molasses was estimated to be from 15 - 30 feet high and moved at 25-35 miles per hour in the area around the tank. The depth was only (only?!!) several feet in the surrounding area. You could not outrun this thing.

"There was no chance of saving anyone in its destructive path. Anyone that attempted to go near the sticky goo got stuck in it themselves and could have been cooked alive. It could suck your boots right off your feet.

The flood killed twenty-one people and injured an additional 150. Some were suffocated, some cooked, and others were swept by the wave into the harbor. I guess you could say that these unfortunate people were molassassed to death. Not exactly how I wish to go. The wave also destroyed millions of dollars worth of property. Homes and warehouses were swept off their foundations and destroyed. Even part of the city's elevated train line was destroyed.

Once the flood stopped, cleanup began. They could not remove the trapped horses from the sticky mess, so they had to shoot them to death. Freshwater from the fire hydrants would not wash away the molasses, so salt water from the harbor had to be sprayed on the land.

It took over six months to remove the molasses from the cobblestone streets, theaters, businesses, automobiles, and homes. The Boston Harbor was also stained brown for six months (must have made for a beautiful photo opportunity).

Believe it or not, there were reports that the molasses would actually continue to creep out of the ground and cracks in the sidewalks for 30 years! Others claim that you can still smell traces of it on a very hot day in the city.

So what happened to cause this mess? No one is really sure, but there are two theories: First, it was believed that the tank was overfilled due to the impended threat of prohibition. It cracked open due to the extra force.

An alternative explanation has to do with the weather that day. On the prior day, the temperature was only 2 degrees Fahrenheit above zero. On the day of the accident, it had quickly shot up to an unseasonably warm 40 degrees. Some believe that this caused rapid expansion of the molasses and overstressed the tank.

This accident is certainly one that will stick in the minds of Bostonians for many years to come.

The Smithsonian Magazine has an online article,

http://www.mv.com/ipusers/arcade/molpark.htm



Types of Molasses and sugar content

There are three major types of cane molasses: unsulphured, sulphured and blackstrap.

There are also three major grades of cane molasses: first molasses, second molasses, and blackstrap molasses.

When sugar cane plant is harvested, the leaves are stripped. The juice is extracted from the cane by crushing or mashing, boiled to remove most of the water, and later processed to extract the sugar. The results of this first boiling and processing is first molasses, which has the highest sugar content because comparatively little sugar has been extracted from the juice. Unsulphered molasses is the finest quality. It is made from the juice of sun-ripened cane and the juice is clarified and concentrated. Barbados molasses is one type of unsulphered molasses, light in color and high in sucrose mainly sold for cooking, confectionery and in the production of rum.

Second molasses is created from a second boiling and sugar extraction, so there is less sugar. It has a darker color and a slightly bitter taste, or as some would say, a more pronounced flavor.

Further rounds of processing and boiling yield blackstrap molasses, used in the manufacture of cattle feed, as well as having other industrial uses. Blackstrap molasses is from the third boil and has a commercial value in the manufacture of cattle feed and other industrial uses. It is 55 to 65% sugar.

Sulphured molasses is made from green sugar cane that has not matured long enough and treated with sulphur fumes during the sugar extracting process. Cooking Molasses is a blend of Fancy and Blackstrap Molasses. It is 59 to 69% sugar.

Cane Molasses is a by-product of the manufacture or refining of sucrose from sugar cane. Cane molasses purchased as an animal feed will contain more than 46% total sugars expressed as invert sugars. If its moisture content exceeds 27%, its density determined by double dilution must not be less than 79.50 Brix.

Beet Molasses is a by-product of the manufacture of sugar (sucrose) from sugar beets. It will have more than 48% total sugars expressed as invert and its density determined by double dilution must not be less than 79.50 Brix. However, some molasses from sugar beets is so well processed it has virtually no sugar. So, if you are buying beet molasses, be sure to find out first if it is sweet.

Citrus Molasses is the partially dehydrated juices obtained from the manufacture of dried citrus pulp. It must contain not less than 45% total sugars expressed as invert and its density determined by double dilution must not be less than 71.00 Brix.

Starch Molasses is a by-product of dextrose manufacture from starch derived from corn or grain sorghums where the starch is hydrolyzed by enzymes and/or acid. It is at least 43% reducing sugars expressed as dextrose and not less than 50% total sugars expressed as dextrose.

The molasses trade commonly use the term Brix as an indicator of specific gravity and as illustrated in Table 4, represents an approximation of total solids content. Brix is a term originally initiated for pure sucrose solutions to indicate the percentage of sucrose in solution on a weight basis. However, in addition to sucrose, molasses contains glucose, fructose, raffinose and numerous non-sugar organic materials. Consequently, a Brix value for molasses will often differ dramatically from actual sugar or total solid content. In fact, Baker (1979) stated that, "With an impure sucrose solution such as molasses, Brix does not represent anything except a number denoting specific gravity and this cannot be related to either sucrose or dry matter content." Regardless, in the United States, Brix is used in the official definition of beet, citrus, starch and cane molasses. Interestingly, molasses is also an excellent chelating agent. An object coated with iron rust placed for two weeks in a mixture of one part molasses to nine parts water will lose its rust due to the chelating action of the molasses.



Panorama of the great Boston Molasses Disaster

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	*How to build a Solar Stove*	*DIY Biodiesel*	*How to Convert your car to EV*
Building a Windmill	*How to Build an Arc Welder*	*Build a $10k 5,000sqf home*	*How to Run your car on Ethenal*
How to find Free Solar Panels	*How to Live off the Grid*	*DIY Automatic Animal Feeder*	*Build an Alchohol Still*
Building a Solar Panel	*Build a Solar Water Heater*	*Super Cooler Plans*	*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.



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. There is no application deadline.



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