

ENERGY SELF SUFFICIENCY NEWSLETTER

September 2005

**Off-Grid Living
Biofuels
Hydro
Solar
Wind**



- * WVO Filtration ***
- * Summer on Šipan ***
- * Stress and Allergies ***
- * Al Rutan on Methane ***
- * Making Ethanol for Fuel ***
- * Small Wind Turbine Basics ***
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From The Editor's Laptop

by Larry D. Barr, Editor

A Collection of Random Thoughts

Sometimes we run across ideas or concepts which really need to be talked about, but they don't necessarily require a complete column or article. I rounded up a few of my stray thoughts for this month, and herded them all into this corral. In one way or another, they all apply to the basic reason for the existence of ESSN.

Paper or Plastic?

Every time I go to my local superstore, I come home with a whole lot of annoying plastic bags. I hate plastic bags. And it seems that the checkers use as many as they can. One bag for each can of Vienna Sausages is a bit much. OK, I exaggerated. But it seems that way. So, how do we get around the problem? I've changed to using canvas bags. They're available a lot of places and they are reusable. Therefore, they don't end up in the landfill. The ones I'm using now came from the Inishowen Maritime Museum and Planetarium in Greencastle, Co. Donegal, Republic of Ireland. But you don't have to go that far to get yours. (I was there anyway) They're easy to find. Try your local craft shops or "green" store. And, among other places, they're available online from [Northern Sun](#). Give it a try, folks may look at you funny – but it's a great conversation starter. And it's a heck of a lot better for the environment and Planet Earth.

Current TV

A new television channel made it's debut on 1 August. It's called "Current TV" and offers a totally unique style of programming. The viewers provide the content. Wouldn't it be great if renewable energy, off-grid living and energy self sufficiency could be seen on television? It can happen now. You'll need to go to their [website](#) and find out what they're looking for and how to submit your program – about five to seven minutes – and, of course, you'll need to charge up the camcorder and dust off your editing skills. This is our chance to share our chosen lifestyle with the rest of the world. Oh, did I mention that they're paying for the submissions they use? And the rate goes up as they use more of your material. We're working on putting together a few segments from here, and I'd sure like to share airtime with some other members of the ESSN family. See you on the tube. Let's spread the word.

Submissions for ESSN

I know, deep down I know, that some of y'all that read ESSN each month have your own stories to tell. You've lived off-grid and learned some things, you've tried to live off-grid and learned some things, you want to live off-grid, you've found a great way to conserve energy. Whatever it is, why not share it with your fellow ESSN readers? If you don't think you're a writer, think again. You have a story to tell? Write like you talk. You don't have to try to sound like Hemingway or Steinbeck. Just tell it like it is. We'll help you with the final polishing if it's needed. Just send your articles as a Word or OpenOffice attachment via [email](#). Or, if you'd like to collaborate with someone else on your article, check out the "Ghost Writing" forum in this issue. Oh, and don't forget the pictures.

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Rebel Wolf Energy Systems

Wall Wart Repowers

There's a lot of small electronic equipment around that's powered by those ubiquitous and annoying wall warts. Or line lumps. For those of us who are endeavoring to run as much gear as we can on 12 VDC, it'd be helpful to know which units are adaptable to operation on that voltage. My original DSL modem just cratered and Sprint sent me another one. They also told me that they didn't need the old one back. So, I'm going to prowl about in the depths of that unit and find out what it will take to run the Sprint 645 DSL modem on 12 VDC. I'm sure some of you have performed the same operation on equipment that you have. Write it up and [send](#) it to us. It's valuable information for the rest of the ESSN family. Again, don't forget the pix.

Hybrid Cars in California

The US Congress has approved a new Transportation Bill that will allow solo drivers of fuel-efficient hybrid vehicles to drive in the carpool, or "diamond", lanes on California freeways. That's a nice step, but I haven't heard anything about offering the same privilege to drivers of alternatively fueled or electric cars. It seems to me that folks who are driving cars powered by ethanol, B100 biodiesel or electricity should also be given permission to share the benefits of the diamond lane. Maybe that provision is in the bill somewhere, but the [LA Times](#) didn't see fit to mention it. In that case, I apologize to the members of Congress. But if the bill limits the use of the carpool lane only to solo drivers of hybrid powered vehicles, they should be ashamed of themselves. The current thrust of alternative fuels is driven primarily by amateur experimenters with homebrew fuels. To deny them the privileges granted to the owners of commercially produced hybrid vehicles is discrimination of the worst kind, and a stumbling block to the timely adoption of renewable fuels in the US. It's time that renewable fuels are given the same recognition as the commercial offerings of the major auto manufacturers.

"Recyclable" Printers

A while back, I picked up an HP PhotoSmart 7150 inkjet printer at my local Walmart for only US \$38. Probably a loss leader for them, but so what? It was a good price, and it came with ink cartridges. When I got it home and unpacked it, I found a sheet in the box explaining how to disassemble the printer for "recycling." That gave me the impression that HP had built a throw-away printer. So, I priced replacement ink cartridges. About US \$65 for the color/black pair. A 38 buck printer that needs 65 dollars worth of ink to keep on doing its job. What a crock! Well, a bit over a year later – and a couple sets of ink cartridges — the little printer is still working just fine. What's the point? Don't be fooled by the manufacturer's penchant for disposable equipment. If you buy a throw-away and it keeps working, don't throw it away just because it needs ink. If you bought a hundred dollar printer, it would need ink too. And you probably wouldn't be so eager to junk it. If we all do our best to get the maximum life out of our gear, regardless of the manufacturer's intentions, we can help to minimize the amount of material that ends up on the local landfill and contribute to the well-being of Mother Earth (and our pockets!).

I hope that I've given you a few things to think about in the preceding paragraphs. Someone once said (I forget who), "The devil is in the details." In the world of energy self sufficiency those words have never been more true. As we've discussed in the past, conservation is the key to energy self sufficiency.

ldb



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Circulation Info

ESSN exceeds 23,000 downloads!

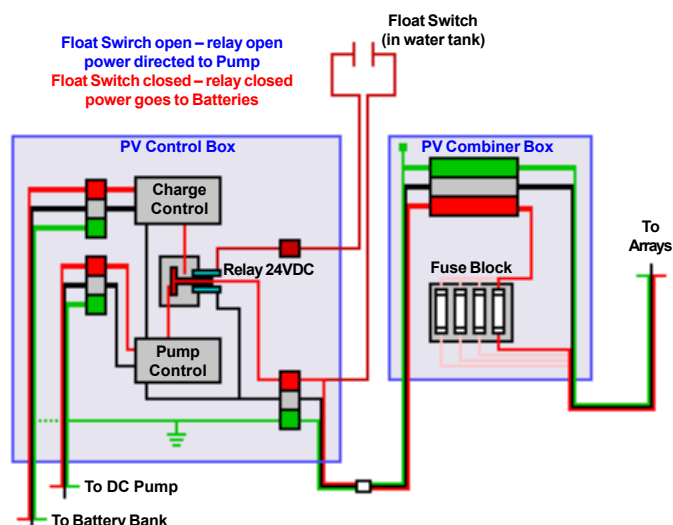
Monthly circulation of ESSN, measured by downloads of the PDF and HTML files, continues to rise and now stands at over 23,000!!! As the word of our existence spreads, and our content increases, we will continue to share our experiences (and yours) in off-grid living and energy self-sufficiency with folks around the world. Thanks for your interest and your support. ldb

INTEGRATED SYSTEM FOR WATER PUMPING AND BATTERY CHARGING

by
Leonard D. Jones, P.E.
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Conventional wisdom, or perhaps “off-grid legend,” says that it’s seldom effective or appropriate to combine batteries into a PV water pumping system; that water pumping systems are best when dedicated to that purpose alone. However, my off-grid construction project (a rammed earth passive solar house) near Crestone, Colorado, required both water pumping and construction power. Working with a limited budget, I needed to incorporate a battery bank and inverter into the system to meet both requirements.

Here’s a schematic:



The PV Control Box contains the following components:

- Terminal Strips
- MPPT Pump Control - Solar Converters Model PTT 12/24-7V
- MPPT Charge Control - Solar Converters Model PT 12/24-10
- Allen Bradley “Bottle Relay” with 24 VDC Coil.



Here’s a view of my construction shed with Colorado’s Sangre de Christo mountains in the background. The piles of earth up front are raw material for my rammed earth project.

Doing so – despite the conventional wisdom – seemed to make sense, as water pumping is required only about 50 percent of the time at most. If the PV panels are dedicated to water pumping alone then the remainder of the potential power is wasted whenever the water tank is full; so why not use the remaining power to charge a battery bank as the source of construction power?

A little research revealed that the voltage/current combination desired for effective water pumping is different from the optimum combination for battery charging. This led me to decide to design and implement a system that that would perform either one function OR the other, as the need arose.



As you can see, the 10" x 10" junction box easily holds the two controllers, the bottle relay, and the terminal strips.

Continued on next page

The system operates like this:

When the water tank is less than full, the float switch is open and the relay coil is de-energized. In this condition, the relay directs power to the pump controller, a Maximum Power Point Tracking (MPPT) device that maximizes the amount of water that will be pumped for given solar light conditions.

When the water tanks fills up, the float switch closes and the relay coil is energized. This re-directs power from the pump to the battery charge controller, another MPPT device that optimizes power sent to the batteries for the particular battery and solar conditions that exist at the time.

This system thus makes the best possible use of the PV panel output for the rather different applications of battery charging and water pumping, performing each function as well as possible. Although PV panel prices have moderated to some extent, the cost of panels is still high, and it is necessary to get the most benefit from each watt of PV-produced power.

The control system could be simplified:

If your solar array is small relative to the size of the battery bank and there is no other charging source, the charge controller is not absolutely required. Normal battery losses should keep the batteries from becoming overcharged.

The pump controller is also not absolutely required. However, the controller will enable the pump to produce at least some water even in the low light conditions of early morning, late evening, and cloudy periods, so it is a worthwhile system addition.

I used a relay in my design because I anticipated that the water tank and the level switch will eventually be located some distance away from the PV system controls; a larger than normal wire size would be required to minimize resistance losses over such a distance. If the tank is located close to the PV controls, a DPDT level switch could control pumping vs. charging manually.

If the user desires, the tank level can be monitored by hand, the relay can be omitted, and the system can be easily controlled by a DPDT toggle switch. I opted for the automatic features because I am only able to work on the project part-time at present. The relay and level switch optimize PV utilization while I'm not on-site.

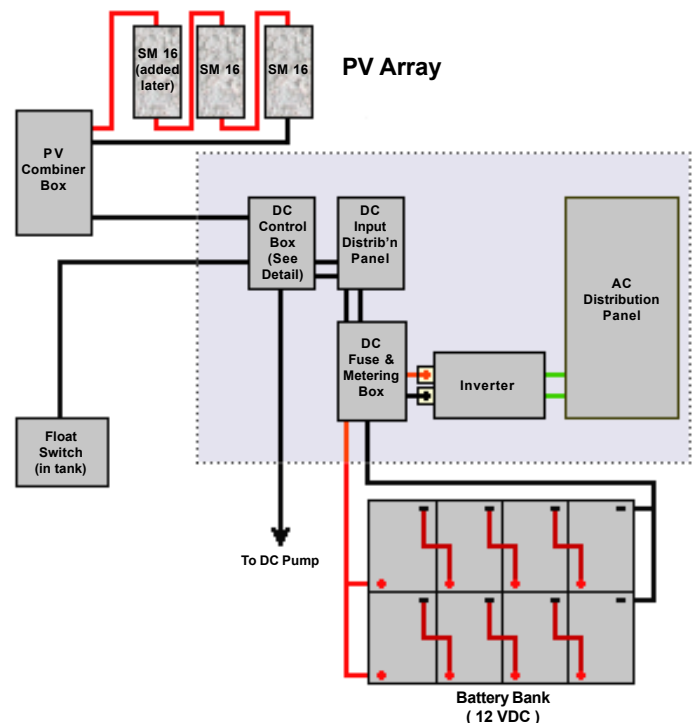
I used a DPDT "bottle" relay because this relay type is readily available at any industrial supply house from a variety of manufacturers; while SPDT relays are hard to find. Having two

sets of N.O./N.C. contacts available made it easy to switch both the positive (+) and negative (-) poles of the DC pumping and charging circuits. This is not strictly necessary; switching only the positive lead from the PV array would be sufficient. Therefore, SPDT level or toggle relays/switches could be used if available.

Several other issues apply to this sort of system. Whether you use a relay or a switch, make sure that the contacts are rated for the current they will be switching. Most industrial power relays meet this requirement easily, but small relays intended for use in electronic equipment may not. For relays, also make sure that the coil is rated for the system DC (rather than AC) voltage. In my system, this is 24 VDC. Other systems may use other voltages. Finally, make sure that the wiring to the relay coil is arranged so that the coil will not be energized unless PV power is currently available. Otherwise, the relay coil may draw power from the batteries unnecessarily.

This pumping/charging control system fits into a larger system that also provides construction power. With added PV panels, the system will ultimately power my rammed earth house.

A diagram of the entire system is shown below. Some details are omitted for clarity:



The power system components and battery bank easily fill one corner of the construction shed.

Continued on next page

It is interesting to note that the MPPT pump and charge controllers will accept a PV array voltage of 50 VDC, significantly higher than the nominal 24 VDC system voltage; and it will convert the PV array voltage into the best voltages for pumping or battery charging, respectively. This feature enabled me to add a third SM46 PV panel to my array in series. This action increased the PV array nominal voltage to 36 VDC (peak 50 VDC) and increased the system's capability by 50 percent with no additional equipment requirements, no additional current flow, and no cost other than the PV panel (and a little of my own labor). Many MPPT controllers have this same feature; off-grid users who desire to upgrade their systems should check to see if they can utilize higher array voltages in lieu of adding additional strings of panels.

The system immediately proved itself capable of supporting a moderate level of construction. It provided plenty of power for 2-3 days of normal construction; more days than that appeared to result in battery depletion that could not be made up without reducing system use substantially. I have already added an Air-X wind turbine to the system to take advantage of the frequent on-site winds for more battery charging. The system will now support heavy construction effort for a week or more. I now expect this system to provide all of the water and most of the electrical power I'll require for part-time construction over the next couple of years.

The balance of power required will come from a propane-fired DC industrial generator, a model used by telephone companies for emergency power and battery recharging at remote terminals and similar facilities. When my house is complete, I'll add a larger PV array and a higher capacity MPPT charge controller to provide adequate power so that my wife and I can live comfortably in the house. The existing array and control system will remain in place for water pumping, to provide convenience power at the power shed, and to add a little extra charge to the batteries whenever possible.

Biography

Leonard D. Jones, P.E.

Leonard Jones is a Colorado Professional Engineer with over 30 years experience in designing, operating, and trouble-shooting energy systems. A graduate of the Colorado School of Mines with a B.S. in Metallurgical Engineering, he also holds an M.B.A. from Nova Southeastern University and a M.S. in Information Science from Regis University. Jones began his career as an officer in the U.S. Army Corps of Engineers. His subsequent assignments have included engineering and cogeneration operations at a large mine and mill complex, managing customer service engineering for a large Midwestern natural gas utility, and facilities management at the National Renewable Energy Laboratory. While currently employed in Information Technology for a large telecommunications company, Jones maintains a private engineering practice, Innovative Technical Solutions, evaluating energy systems and designing passive solar earthen homes. His primary current interests include earth building and assisting non-traditional builders in evaluating alternative technologies. Jones' own off-grid passive solar rammed earth house is now under construction near Crestone, Colorado.



He can be reached via e-mail at ldjone2@buildwithearth.com



The complete control system

Continued on next page

SUMMER ON ŠIPAN

Suzanne Ubick

THE GLAVIC HOUSE: OFF GRID LUXURY



(To remind readers where Suzanne is writing from)

At the turn of the 20th century Federico Glavic, in the Šipan tradition, went adventuring with the merchant marine. Having built up some capital, he entered the cattle business in Chile and made a fortune. He brought his money back to Šipan and, following a much older tradition, built a palatial summer residence. There are traces of Roman villae rusticae on the island, some of which were constructed atop the remnants of Greek summer palaces.

One of the wealthiest land-owners in Croatia, Glavic – the local boy made good – was on a par with Onassis. Shrewd as well as lucky, he invested his money wisely. He owned the largest hotel in Zagreb, as well as at least 15 houses in Dubrovnik, and several houses on Šipan. Like Onassis, he extended his reach to the sea as well as keeping an anchor on land.

He held a 50% share in the shipping line Dubrovacka Ploviba. Rusticating in summer, he spent winters in Dubrovnik and Zagreb, amongst the gaities of those cultured and most beautiful of cities.

Federico married, and his only child was a very beautiful, sought-after daughter. The young woman fell in love with an unsuitable suitor. Her father refused her lover her hand, and the young people killed themselves rather than break their troth. On his death, Glavic left his property to his nephew Tomitsa, who lived in Peru.



The younger Glavic studied law and later successfully opened and operated a bank. His son married my mother-in-law's cousin, and it is to my mother-in-law, Nicolina Ljubic, that I am indebted for this information. Nike remembers the wake that was held for Federico's funeral. His shipping line ran a special free boat for the Šipan inhabitants, with coffee and sandwiches to sustain them on the trips there and back. This

service was so much appreciated that three round trips were necessary. Nobody is admitting to taking it more than once.

At the time, the grid didn't exist in this part of the world although gas and water were making their way into large cities in Britain and Europe. Self-sufficiency was a way of life, taken completely for granted.

Federico Glavic planned his villa rustica well. He snuggled it close to a hillside, so that his cistern was actually above ground level, with minimal digging required. The roof of the cistern formed the floor of the terrace in front of the house, and a well was set into it. Servants drew water here, with a bucket let down on a chain – the marks are worn into the relatively soft limestone. Cleverly, Glavic set a walk-in coldroom into the heart of the cistern; a vaulted cavern with a heavy door, its entrance flanked by storerooms. Surrounded on three sides, and above, by tons of water held by tons of limestone in massive blocks, it's cold enough in there to hang a beef carcass in

the height of summer and keep it fresh till it's all been eaten.

To one side of the coldroom, but separated from it by water, is a bakehouse with a big built-in oven fired by massive chunks of wood. Here huge quantities of bread were baked daily, except of course for Sundays – the Glavic family were devout Catholics – without heating up the house. Most of the cooking was done here, with a small kitchen upstairs providing snacks and drinks. The wood used for the oven would have been olive; olive trees live for hundreds of years, growing slowly, and the wood is both very dense and oily. It burns hot and over a long period, with little smoke.



Šipan summers are hot, and humid. Over the last couple of weeks, the temperature has been in the mid eighties, and humidity has been hovering around 75 – 80%. Nevertheless, it has been comfortable. In the Glavic house, for the Glavic family, it would have been downright luxurious.

By the way, the house and its demesne are currently on the property market.

Suzanne Ubick

A photograph of a large green field with a small building in the background. The field is filled with tall grass and some small trees. The building is a simple, light-colored structure with a dark roof. The sky is blue with some clouds.

FOR SALE

**CONTACT YOUR FRIENDLY REALTOR
SUZANNE UBICK**

BUILDING A VERY SIMPLE SOLAR WATER HEATER

**Eighth in a series of Articles on
Natural Heating and Cooling**
by Laren Corie

This month I thought I would present a unique way to build a variety of simple, very low-cost, low pressure Solar water heaters. I will be showing just one version but I am sure some of you will have other ideas for how you can use this basic concept to warm a lot more water, perhaps in a larger configuration as a swimming pool heater. It is up to you – just remember, this is only a low pressure system which cannot handle being hooked directly to your standard plumbing system. I am presently designing a system where a similar approach is used for heat storage and heat exchangers. The little project I will show you here is a portable camp water heater. You simply set it in the sun, and it gives you warm water, without getting dangerously hot. This type of heater can be built in a variety of configurations, from the little one gallon stand-up heater, described in this article, up to multiple, hundred foot long, seventy five gallon sections, that would be just about as simple to make.



The basic materials are inexpensive and easy to find. They consist of:

1) 4" corrugated, non-perforated HDPE (high density polyethylene) drainage tubing which can be purchased at home stores, landscape suppliers, and many plumbing supply houses, for as little as \$3 for a ten foot section, or about \$27 for a full one hundred feet.

2) 4" Fernco Qwik-Cap, which is an EPDM rubber cap, with a stainless steel clamp, which is normally used to cap clean-outs, or to pressure test plumbing. This is necessary, because it is very difficult to bond anything to HDPE. These caps seal it well. Price at most any home store, about \$4. Fernco also makes couplings to connect multiple pipe sections.

3) Three-liter PET (polyethylene terephthalate) bottles. These are the large soft drink bottles. It is possible to use the two liter bottles, but they are not large enough to reach around the corrugated pipe, so would need to be taped together. The three liter variety simply slide down over the pipe. The top piece, if made from a two liter bottle, would also not fit. My one gallon heater used three of these bottles. If you don't use soft drinks, you could get/buy them from people who are turning them in for deposit, or recycling.

4) I also include a one quart plastic food container, that came with an order of Chinese food. Yep! that's right ;O) It is not an essential component. I use it to set in the top of the pipe, in order to reduce evaporation and condensation in the top of the heater. It also makes a handy container for pouring out a little water.

The assembly of the heater is fast and easy. First, cut the corrugated pipe, to your desired length. It is thin, so it can be cut with a sharp pair of scissors. Every foot of length will hold just under three liters, or 3/4 of a gallon. My one gallon heater stands easily, and solidly, even in grass, or on uneven ground. Taller heaters will be less stable.

The EPDM rubber Fernco Qwik-Cap is simply stretched over the end of the corrugated pipe. Then, the clamp is tightened.

The trickiest part of this easy construction, is cutting the ends off the bottles, and fitting them over the corrugated pipe to function as the water heater glazing. This is also done with sharp scissors, and perhaps a utility knife to start the cuts.

Continued on next page



The bottles have tapers at both their top and bottom. You will want a nice straight cut on the bottom of the first bottle, so that it will set down evenly against the Qwik-Cap. One end of each bottle will need to be cut slightly into the taper, from where the other is cut, leaving one end slightly larger than the other. This way the upper bottle can fit down tightly over the lower bottle, and the top cap (actually the lower end of a bottle) will fit down snugly over the top of the other bottles. By cutting them this way, they will all fit together without any gluing.

The PET plastic will last well in sunlight, but will eventually degrade from UV exposure, and need to be replaced. As a camp heater, it may never get enough exposure for this to be required. I have left mine setting in the sun, since mid spring, and the glazing is just as clear and pliable, as the very first day. However, I've been told that when similar bottles are used as Solar collector glazings in India, that they only last about two years. Nevertheless, not all PET bottles are created equal, and I suspect that the thin water bottles have a much shorter life than the thick three liter bottles prescribed here. If you decide to experiment with the tubing for a pool heater, you will not need the PET bottle glazing, and can use the tubing alone. The goal of a pool heater is generally to only warm the water to around air temperature, so the corrugated surface should do quite well. It is blackened, which provides it with a great deal of UV protection. My little batch heater usually produces water in the 120°F (50°C) range.

High density polyethylene is often rated for potable water. However, there is no interest in rating drain pipes for that, so

these corrugated pipes are not rated for drinking water. How you use them, and for what, is up to you. The little heater produces nice temperatures for washing. It works fairly fast with its small quantity of water, and the glazing, with its air spaces, provides better insulation than standard black bag camp water heaters. If you want to keep the water warm for a much longer time, just slip the sleeve of a jacket down over it.

Since this heater is able to collect sunlight 360° its ability can be increased by adding a simple reflector, like the windshield shade in my picture. A longer version could just lay on the ground with one end propped up, or you can simply fill it and seal the end with a second Fernco Qwik-Cap. I am sure you can come up with other good uses for this simple assembly. The HDPE pipe and PET glazing are good for continuous temperatures, up to about 165°F (74°C) but not very much pressure. The EPDM rubber Qwik-Cap is good to about 350°F, and has excellent UV protection.

Let me know about you creative ideas for this simple system. Perhaps, we could do a future feature on the results. As usual, I will be available on the "LittleHouses" Yahoogroup to answer questions.

Wishing you sunshine.

-Laren Corie-

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and Consultation for Owner-Builders, Since 1975
<http://groups.yahoo.com/group/LittleHouses>

SMALL WIND TURBINE BASICS

Part 3

by Dan Fink

In parts 1 and 2 of this series, I tried to explain the basic physics and math of wind turbines and how they relate to power output potential. If you are seriously considering installing a wind turbine for your on- or off-grid home or cabin, it is critical to know what range of power output you can expect at different wind speeds. The key concepts from parts one and two are that potential power from the wind increases by a factor of 4 when the diameter of the rotor doubles, power increases by a factor of 8 when the windspeed doubles, and that wind turbines must fly well above any obstructions. So, a potential site must have good winds with little turbulence, and the swept area of a turbine is far more important than the 'manufacturer's rated output.' If provided by the manufacturer or from independent test data, the figure 'estimated power output per year in kilowatt hours' is the most important data on which to base your decision of whether to buy a wind turbine, and which size and model to purchase. Low winds require a large turbine to make any useful power.

SITING

Installing a wind turbine close to the ground is very much like installing solar panels in the shade – a large part of your investment is wasted. General guidelines are that wind turbines should fly 30 feet above any obstruction within 300 feet. Windspeeds increase as you go higher, and turbulence decreases. Turbulence affects all wind turbine designs, and besides dramatically reducing potential power, turbulent winds near the ground buffet any turbine, causing serious stress on all components and sometimes premature failure.

In general, urban and suburban wind turbines are possible only on a very small scale because of local building codes and impact on neighbors. And 'small scale' means a very small turbine, which won't do much to offset the typical power use of a typical suburban home. (see parts 1 and 2). Most building codes require that any tower have a 'fall zone' that does not impact any neighboring property, and also restrict the height. Locations near airports have tower codes even more strict, and your relations with neighbors regarding aesthetic and noise concerns must be addressed. If you are on a small urban or suburban lot with many houses nearby, your best bet may be to invest the money you considered for a wind turbine into refitting your home with energy-efficient lighting, appliances, and heat, with the future option of a photovoltaic system in mind too.

If you are in a more rural area and can comply with local restrictions, it's important to put your tower as high as you can at the best possible location. This is expensive—in general a good tower will cost **at least** as much as the wind turbine that will fly on it! Local geography, property lines, and cost may limit your tower options. Up here in our remote mountainous area, many of us are forced to cheat the 30-foot-above-300-foot rule all the time. The key factor is, how much are you investing in your wind turbine and tower? If it's homebrewed and inexpensive, just fly it as high as you possibly can—if you built it, you probably know how to fix it. If turbulence from being flown too near the ground causes a failure, your loss is only some repairs and engineering lessons learned. If you just dropped big money on a commercial turbine, you'd be crazy to fly it too low—and no commercial installer would even touch the job! Seek expert opinions, they often cost only a couple beers.

Photo Comparison of Sites

So let's have a look at a few pictures taken at real sites to see what makes them suitable, or not. We'll start with a couple of good ones:

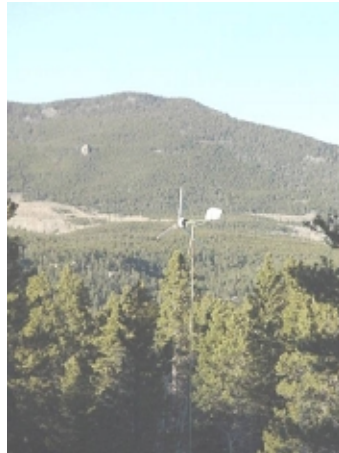


Bergey Excel 10kW on an excellent site, Parker, Colorado, USA
Photo by Dan Fink



Homebrew 1.5kW turbine flying high in Colorado, USA
Photo by Dan Fink

Continued on next page



Homebrew turbines flying at pretty good sites, Colorado, USA.
Both could use another 10-20 feet of tower
(notice local tree heights)

All photos on this page by Dan Fink

Opinions vary on whether detailed wind data acquisition should be used for a siting decision, or simply general wind data for the area. My opinion is that the cost of your pre-purchase data acquisition should directly correlate to how much you are planning to spend on the installation. Are you looking at spending US\$30,000 for a 12 kW Bergey to offset your home or business power use on the grid? Darn right, erect a meteorological (MET) anemometer tower and collect data for a year or two, then take it to an expert analyst. Planning to spend US\$3000 on a small commercial or mid-size homebuilt wind turbine for an off-grid home? Put up some inexpensive logging anemometers on PVC pipe masts, and watch your input during windy months or for a whole year. US\$800 on a tiny wind turbine or homebuilt mid-size model for your vacation cabin? Just do it! Keep in mind how much power you can expect from different sizes of turbine in your area, and the importance of flying it as high as possible.

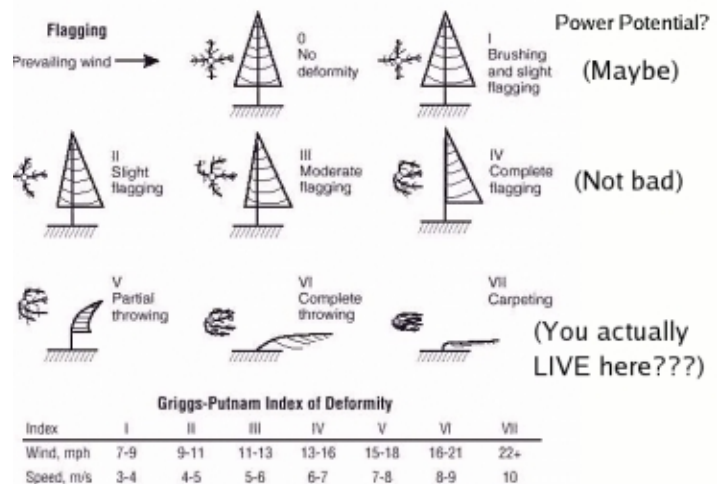
Useful data on wind power potential at a given site can be gleaned by simply observing the wind first hand. Ridge tops are usually the best turbine locations, so how tall are the trees on your ridge? How big a tower do you need to get 30 feet above them? About how fast is the wind blowing each time you visit? Keep a log. And how fast are the trees growing in height each year? Do the trees on your ridge have more branches on one side than the other? Such tree 'flagging' can also be a rough indicator of wind potential at a site. Also, talk to neighbors that have lived in the area a long time.



This could perhaps be a 'little' higher?!



An alternative car alternator - or is it a swamp buggy?



GP Index – Courtesy NREL

Continued on next page

Wind data logging can be as simple and cheap or as complicated and expensive as you choose to make it. If you are planning a substantial investment, choose your logging equipment accordingly. Some government and non-profit organizations are making advanced wind data logging systems available on loan for zero or small cost – search Google for “anemometer loan program” to find details for your area.

A professional-grade, ready-to-fly logging MET anemometer system (including 30-meter tilt-up tower) can be had from [NRG Systems](#) for a cool US\$3000—intimidating, but not if you are looking at spending US\$30K on a turbine. US\$600 to NRG systems will get you an excellent professional instrument, even capable of plotting the Weibull distribution of your wind speeds (see part 1)—you build your own tower or tree mount for it, and be sure to fly it high or else turbulence will compromise your data. Home weather stations by Davis Instruments, Oregon Scientific or LaCrosse come in at around US\$300. For bottom feeders like me, US\$40 will get you the parts to build a homebrew [Anemometer](#) built from a bicycle speedometer, or an even cheaper [Easter egg anemometer](#). And check out the [Vortex anemometer](#) from Inspeed.com for a US\$60 commercial versions of the bike speedometer anemometer, and a US\$99 anemometer with computer interface and software that give an on-screen display and also puts your wind data directly into a spreadsheet file.



Chasing a storm with a Vortex anemometer
[Courtesy Inspeed.com](#)

TOWERS

There are two basic types of towers for wind turbines:

Fixed – The kind you have to climb. If you (or a friend, or a professional wind turbine installer) don't mind high climbing and know the necessary safety precautions, harnesses, and knots, a lattice tower with 3 guy wires can be very cost effective. The tower sections, and finally the wind turbine, are raised one at a time using a gin pole and davit, or the whole thing at once with a crane. Lattice tower sections are often available used or as surplus. Freestanding, fixed towers are more expensive: wider at the base and narrow up towards the top, but they need no guy wires. At very steep, craggy or tree-filled sites, fixed and freestanding towers have the advantage that a much smaller 'footprint' of level ground free of trees is needed.



Professional wind turbine dealer, installer and mechanic Victor Creazzi of [Aerofire Wind Power](#) on a routine service call.

Seriously acrophobic Dan Bartmann of [Otherpower.com](#) is assisting. Victor wisely refrained from any 'tower-top humor' after he got DanB up there!

Photo by Dan Fink

Continued on next page



Typical freestanding tower with no guy wires.
Requires a large concrete base.
The turbine shown is an Atlantic Orient located at the NREL,
NWTC, Golden, Colorado, USA

Photo by Dan Fink

Tilt-up – This is a great alternative for non-climbers, though it is often more expensive. A tilt-up tower has the big advantage that you can do all your adjustment and maintenance to the turbine while it's on the ground, instead of while you are hanging from the tower top. It also uses a 'gin pole' to raise it, but in this case the gin pole is a lever arm that stands straight up when the tower is down, and lays along the ground when the tower is up. Tilt up towers use 4 guy wire locations instead of 3, and the guy anchors must be perfectly square to the tower base. Tilt-up towers are generally made of steel pipe, which is heavier and more expensive than lattice. The prospect of high climbing a fixed tower might convince you that the added expense (and required large level area, clear of trees and obstructions) of a tilt-up is justified.



A 40-foot tilt-up tower being raised via pickup truck and gin pole.
Colorado, USA

Photo by Dan Fink

Tower Bases and Guy Anchors

The tower base actually does not receive much stress compared to the guy anchors—once the tower is erected, all of the force on the base is straight down, from the weight of the turbine and tower. Fixed towers require a chunk of concrete at the base, and the manufacturer's specs will tell you how much mud to pour. A metal plate is bolted into the concrete and the lattice sections attached to the plate. Freestanding towers need even more concrete – with no guy wires, the weight and depth of the base are critical. Again, follow the tower manufacturer's recommendations.

Tilt-up towers benefit from a concrete base because of the side forces when raising or lowering the tower, but some perfectly good commercial designs use a flat metal base that's simply spiked directly into the dirt. What's most important is the strength of the guy wire anchors, which are usually either concrete or (when digging is impossible) large metal pitons sunk into holes drilled into the rock, and further secured with masonry epoxy. Fixed towers give you a little leeway on exactly where the 3 guy anchors are placed, but tilt-ups don't. If the 4 guy anchors on a tilt-up are not perfectly square and level with the base and each other, the side guy wires may alternately tighten and loosen during raising and lowering. This requires diligence and very slow action by the owner during erection, because wire rope guys don't give any visible indication of how much tension they are under—they look the same whether there's 100 pounds of force on them or 1000. A broken guy wire can be a disaster for the turbine, tower, and could even kill the owner. Seek expert advice if you've never raised a tilt-up tower before! It would be wise to do the same if you're thinking of a fixed one, too.

Lightning Protection and Wiring

Wind turbine towers must be properly grounded or induced current from a nearby lightning strike could fry the rest of the components of your power system. Generally, the metal components of the tower and turbine are grounded to one or more ground rods near the tower base. The electrical wires from the turbine are NOT bonded to this ground—they run into the house, and are grounded by the power system's main ground. Very tall towers may have a ground rod at the base plus an additional ground rod at each guy anchor, with all guy wires that connect to that anchor bonded together.

The wires from the turbine to the house must also be properly sized to avoid too much resistance heating loss. Follow the manufacturer's recommendations, and be sure to factor in

Continued on next page

the tower height when making your calculations. Many turbine manufacturers no longer make their mid-size models in 12V configurations, it's now 24V or 48V only. Low voltage 12V systems will need thick, expensive wire, and internal losses in the turbine's generator are also a problem at 12V. If you are pricing wire for installing a 12V turbine a few hundred feet from your house, you'll quickly see the advantage of upgrading to a 24V or 48V power system!

Power Regulation

Almost all small off-grid wind turbines use what's called a 'dump load controller' to regulate their power input to the system. The raw output of a small wind turbine is "wild AC," meaning it varies in both frequency and voltage and is not directly useful for much of anything. The controller converts this to DC for charging the home's battery bank, and the batteries themselves regulate the incoming voltage level. They keep it down to their own voltage, UNTIL the batteries are full – at that point, they can't regulate the voltage any more. Solar panels can simply be disconnected from the system, but disconnecting a running wind turbine (letting it 'free wheel') can be a disaster. The turbine will overspeed and possibly come apart. It must always be connected to a load.

That's where the dump load comes in – when the batteries fill, the controller starts diverting all or part of the incoming power to electric air or water heating elements in your house to keep a load on the turbine without wasting the incoming power. Commercial turbines come with this system included, and homebrew builders usually make their own heating element arrays and use a commercial controller (such as a Trace C-40 or C-60) set in dump load mode to handle the diversion.

Grid-tied systems are regulated in a similar way. If the system includes batteries, the only difference is that the grid itself is the dump load, and any extra power beyond what your home is using runs your electric meter backwards. In systems without batteries, a special grid-tie inverter is used (one example is the WindyBoy) to convert the turbine's wild AC directly into sync with the grid.

Noise, Birds and Bats

After your wind turbine starts flying, you'll start getting questions from friends and neighbors about noise, dead birds, and dead bats. There are some pretty noisy commercial wind turbines on the market, but most are extremely quiet. If noise is a concern for you, be sure to talk with your dealer or installer and visit some working small turbine installations to hear the noise for yourself. I usually describe the sound of our homebrewed turbines up here as about the same as someone

riding by the house on a bicycle. In higher winds, the turbines make a bit more noise, but the noise threshold is just barely above the sound of the wind in the trees.

Bird kills (and more recently, bat kills) are a big issue for the under-informed, and those people who are against wind power development. In reality the issue is minor and stems from early utility-scale wind installations such as the wind farm at Altamont Pass in California 30 years ago. This installation was inadvertently sited in a bad area of the local ecosystem, full of raptors. Commercial wind farms have been sited with birds in mind for many years now, and derisive names like "Raptor-matic" and "Cuisinart in the sky" are just anti-wind-power hype. The biggest modern killers of birds are power lines, cell phone and other communications towers, pesticides, and domestic cats. See [Mick Sagrillo's article on bird kills for the AWEA for more details](#). We have over a dozen wind turbines flying in our local off-grid area, and no one has reported a single bird kill, ever.

The bat kill issue has only cropped up recently and only at certain installations, but the problem is currently being worked on by the best and brightest ecologists and engineers. Just like the bird problems 30 years ago, the issue seems to stem from bad siting of the turbines in bat flight paths instead of any intrinsic danger from the blades. Zero dead bats reported up here. Though we recently got to witness a pair of male Broad-tail Hummingbirds engaged in an aerial duel in, around and through the blades of a local turbine running during high winds—an amazing display that caused no harm to the birds, and was like watching the Ornithological Olympics for us!

Wind Turbine Watching

Before my wind turbine went up, I cursed the constant February winds that blast our high mountain location. Now, I see the wind in a new perspective. In fact, I find watching wind turbines to be much more entertaining than watching television. Those first slow rotations in a gentle breeze provide the anticipation, and the excitement kicks in when the wind gets strong enough to give the correct angle of attack on the blades to provide lift (see part 2 in the August 2005 edition of ESSN) – the acceleration is dramatic. And then watching a turbine furling in high winds is a lesson in physics beyond compare. Be sure to find a spot in your house where you can sit and watch your turbine through a window, and see both your anemometer and power input meter at the same time. In addition to the wind power that you are harvesting, you'll gain power by shutting off the TV too!

Dan Fink

WVO FILTRATION

by Kelly Boyd and Steve Spence

PROJECT: Waste Vegetable Oil (WVO) Heater/Filter Unit

PURPOSE: Filter WVO faster and neater

Background notes

If you've used the bag filter method for any length of time, you know it's slow, messy and frustrating. The bags quickly block up, the oil needs to be warm for good flow, and spills are inevitable. You may have tried to wash out the bags for re-use to save money, like me, but that's a horrible job if there ever was one. Now that I have 2 cars running on WVO, a better method is needed.

There are combo pump/filters on the market, but they have no heater, as far as I know. I considered adapting a water heater, but the fittings aren't right for the purpose, so I decided after talking to Steve Spence to build from scratch.

Using a 30 gal. drum, and a discarded water heater, I installed two 1440 watt 120VAC elements 6 inches from the bottom of the drum. Now these elements were standard high watt density elements, for that's all I had at hand at the time, but in retrospect I would choose low watt density types as they run at a lower surface temperature for the same amount of heat delivered. A typical high watt density element delivers around 150+ Watts per square inch. In contrast, a low watt density element delivers around 50 Watts per square inch, so its surface temperature is much lower. Another advantage is that the outer sheaths of low watt density elements are made from incoloy, a corrosion resistant alloy of nickel and chromium, and are designed to survive "dry firing" (they don't burn out when not immersed in a liquid).



Such elements can be recognized by being longer than the usual element, and often folded over or "rippled" so they fit easily into a standard water heater.

The bushings for the elements had to be cut from the old water heater, and I saved the thermostat brackets for later use. Sediment will settle in the bottom of the barrel, so for cleanout a 4" PVC fitting was installed, and a 3/4" brass drain at the very bottom of the barrel. It took 4 tries before I achieved

a water-tight installation on the cleanout. The key is silicone caulk inside and 2-part epoxy plumber's putty on the outside, with caulk on top of it and on the threads of the plug. Not pretty, but it works!

The 3/4" line that feeds the filters attaches almost at the mid point of the barrel. This ensures that the heater elements are never accidentally exposed, and allows plenty of room for settling. In reality, you would not want sediment to reach the heater elements before cleaning. I paid a local welding shop to cut the barrel top off, and the holes to my specs, and they did a great job for about \$10 a hole. They also brazed in the water heater bushings.



I had a 12 volt pump from Northern Tool, which is attached with hose fittings just after the valve, with a 20 micron water filter first as the rough duty filter, then a 5 micron finish filter. The valves are needed in the event of a filter change, or a problem with the pump. I added a toggle switch to the pump for easier operation.

Continued on next page

A single thermostat is adequate, since both elements are at the same level, so the wiring is jumpered to the 2 elements from there with #10AWG cable (in accordance with NEC regulations. The photos show stranded wire, but I later changed it to solid wire). The insulation is "space blanket" type bubble wrap with radiant heat barrier. It doesn't absorb WVO.

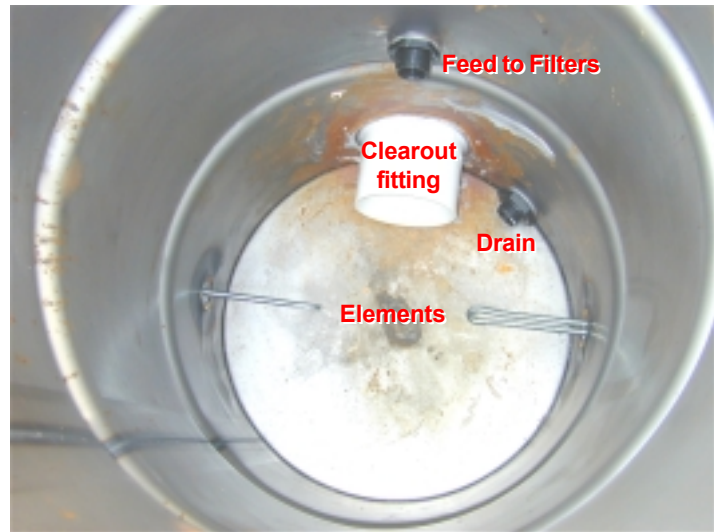
The maximum current drawn by the elements when both are in operation is $2 \times 1440 / 120 = 24$ Amp, so a 30 Amp circuit breaker was used at the "workface", backed up by the standard circuit breakers and earth leakage circuit breaker in the house. I fired up the heater with the thermostat set to the lowest setting (the maximum temperature I wanted was 130F), and the thermostat clicked off after the oil had warmed up, taking about 10 minutes in all. I opened the valves, switched on the pump, and was gratified to get a 5 gal pail filled with clean WVO in about 2 min.

I estimate I spent about \$300 building this, and about 10 hours of my time. It was well worth it.

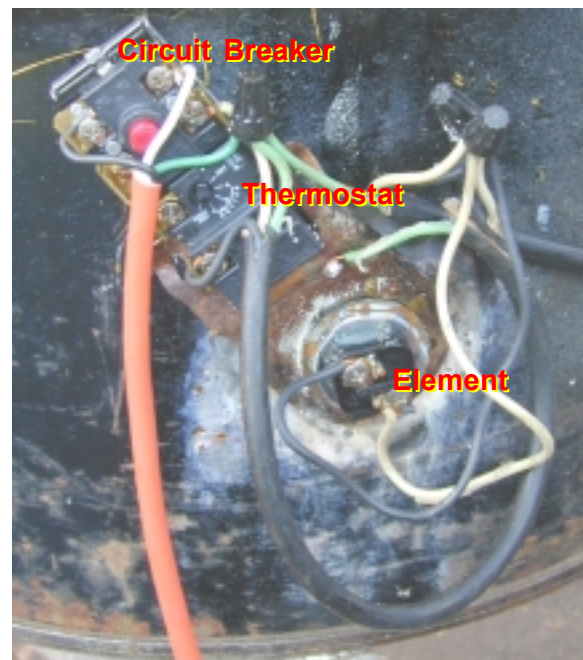
The next stage in this project will be to explore other methods of heating the oil. Unlike other processes, lowering the viscosity of the oil to make filtration easier does not require high temperatures (around 130F is enough). We're therefore looking at ways of warming the oil "on demand" by passing the oil to the pump via a heat exchange coil submerged in boiling water. Only one heater element would then be required as the water bath could be quite small, and all that business of cutting holes in the drum for the heater elements could be bypassed. This would also have the advantage of overcoming any fears held by ultra-nervous people (like our worrywart Mike Nixon!) about sticking electrical heating elements directly into oil intended for use as a fuel – despite the fact that we have never experienced any problems with that, and many deep fat fryers use elements immersed directly in the oil.

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 Contributing Editor, <http://www.off-grid.net>
<http://www.rebelwolf.com/essn.html>



A look inside the drum



Close-up of the circuit breaker and thermostat mounted on the drum



All cosy and smart
 in its shiny
 warm blanket

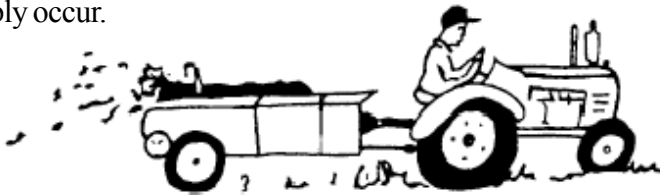
THE METHANE PROCESS

Third in a series by Al Rutan,
the Methane Man

© Al Rutan 1992

First published in Home Power #28 • April / May 1992

Mold and mildew have been seen by everyone. Most people have observed the process of rotting. We know it is common in nature. Methane gas is just as common, but not as observable. Anyone near a sewer manhole or a plumbing vent pipe can get a whiff of the methane process in action. The reason for saying this is to alleviate the apprehension that the methane process is going to be difficult to harness. It's no more difficult than making a loaf of bread. If the conditions needed are present, the desired result will invariably occur.



What we are considering is a biological process in which we use the waste product of bacteria. We shouldn't even call the little creatures bacteria but more accurately "methogenic micro-organisms."

Primeval Life

In the process of evolution, they antedate the formation of bacteria. They are one of the very earliest forms of life. When scientists explore outer space with telescopes that can separate light spectrums, they look for the presence of methane gas. If the gas is present, there is evidence for the beginning of life. For our purpose, we are going to refer to these methogenic micro-organisms simply as "bacteria." They are curious little critters. Their waste product burns. Not only does it burn, it burns very well. Combustion produces only carbon dioxide and water vapor. There is no ash, no soot, no tar, no dirt of any kind. It's a very efficient fuel.

Characteristics

This fuel is composed of carbon and hydrogen. Its chemical formula is CH_4 . It has an octane rating of 110 and produces around 1,000 BTUs (British Thermal Units) of heat per cubic foot of gas. Because most gas is invisible, it seems mysterious. If we think about our own chemistry for a minute, it won't seem so strange. We know that we breathe in oxygen

and exhale carbon dioxide. So we, ourselves, are gas producing organisms.

Gas Makers

If we think about this, then the process of the methane bacteria doesn't seem so strange. The part that is "strange" is that it burns. If mixed with sufficient amounts of air, it burns very rapidly... explosion! In nature, some bacteria operate best in the presence of air because they require oxygen, and some function only when air is excluded. The methane bacteria are of this latter type. When exposed to air, they die. Because they live and function only when air is not present, they are called anaerobic or "without air" bacteria.

Natural Gas and Sewage Gas

What is the difference between natural gas and sewage gas? Virtually none. For all practical purposes the bacteria which make the gas are the same. Natural gas sold by the utilities is 90%, or better, methane. It has been made in the ground over eons of time and in most instances is almost pure methane because the ground has purified or "scrubbed" the gas. The only difference between gas produced in the earth and gas made in sewage plants is that in the sewage plants the process is speeded up. In speeding up the action there are several gases produced, notably, carbon dioxide. In a sewage plant the mixture is about 70% methane and 30% carbon dioxide, with trace amounts of hydrogen sulfide. The carbon dioxide largely dissipates from "natural gas" over time. The speeded-up process product, including the carbon dioxide, is referred to as "biogas." Actually all natural gas is "biogas" because all of it was produced from something that was at one time living. The only distinction is that so-called "biogas" is produced in a shorter time from things that have been living recently. Making methane for ourselves, we hasten the process.



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How Does it All Happen?

There are two types of “without air” or anaerobic bacteria that work together to make methane. The first type we’ll call “acid forming.” Their function is to feed upon raw organic material. They produce no methane, only carbon dioxide and some acids and “food” for the second bacteria type, the methogenic micro-organisms. The “food” consists of simple sugars, simple alcohols and peptides. When the methogenic micro-organisms in turn feed upon this simpler fare they produce methane. Thus when organic material is placed in a container where air is excluded, both carbon dioxide and methane are produced.

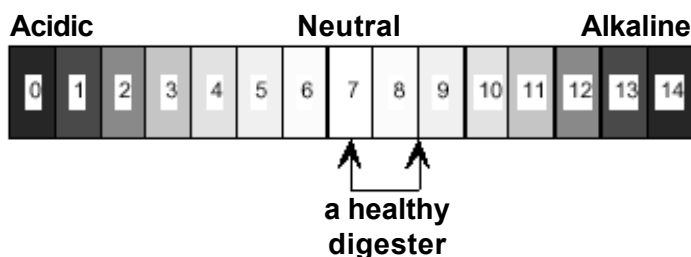
Need for Balance

The methanogenic micro-organisms need the food provided by the acid-forming bacteria, but they also need a neutral environment. If the right balance between acid and base (alkaline) is not present, the methane micro-organisms are in trouble and no methane is produced. They have to have a pH of 7 to 8.5 in order to be normally active.

What Does pH Mean?

I think it’s important not to assume that everyone is familiar with pH. Webster’s defines pH as “the negative logarithm of the effective hydrogen ion concentration... used in expressing both acidity and alkalinity on a scale of 0 to 14 with 7 representing neutrality. Numbers less than 7 represent increasing acidity and numbers greater than 7 represent increasing alkalinity.” So the term pH means percentage of hydrogen, or more precisely, proportion of hydrogen in relation to the hydroxide ion in a given material. It’s the negative logarithm of the hydrogen ion concentration, so a pH of 7 means that the concentration of hydrogen ions is 10^{-7} . Aren’t you glad you asked? Anyway, it’s important information for keeping the digester healthy and happy. The ideal pH for digestion is from 7.5 to 8.5.

The pH Scale



How to Get a Reading

How does one measure pH? This is the easy part. Chemical supply houses and even most drug stores sell rolls of paper (called litmus paper) and/or little plastic strips that turn color when dipped in solution to tell you what the pH is. There is a slightly different color for each of the different pH numbers. You tear off a piece of the litmus paper about 1 1/2 inches

long and dip it into a little of the slurry. The paper will start to change color within seconds. When compared to the color scale on the container, you can tell right away what the pH of the slurry is.

Why the Process May Drag

Generally if there’s a problem, it’s that the slurry is too acidic (pH below 7). If there is a lot of new, raw, green material placed in the digester, the acid forming bacteria have a field day. The methane bacteria are so annoyed by the high acid concentration, they simply can’t function. When this occurs, it can take a long, long time for the methane process to get under way naturally. This generally occurs only in the beginning with start up or if too much new material is added at any one time. If a measured amount of new material – no more than 1/40th of the total liquid volume of the tank – is added, then the new material is dilute enough not to upset the balance. At start up, though, there’s a lack of micro-organisms, and an inclination towards excessive acidity. Understanding this, we can see why some of the early literature on making methane states that the start-up time can be anywhere from three weeks to three months. This is assuming that one is beginning with totally “new” material without the assist of some already partially digested slurry. A three month start-up would discourage almost anyone from attempting to harness the process..

Starting Up

Partially digested slurry is kind of like sourdough starter. It has large populations of the right kind of micro-organisms to digest raw material and make methane. You can start from scratch, but it’s faster if you can get some activity that’s already established. When I started a small digester in 1976, I seeded it with some slurry from the St. Cloud, Minnesota, sewage plant. The plant engineer told me at the time that the plant was so overloaded with wastes from a local meat packing house that the digester was just “going through the motions” and really not working properly. I took some of the slurry anyway. What the heck. It was free and I needed something to get the tank producing. After a few days I started to get methane and then I lost it. The tank was still producing a lot of gas, but it was carbon dioxide – it didn’t burn. The pig manure I had begun to feed the digester along with the slurry from the St. Cloud plant was just too much raw material for the process. So there was a lot of carbon dioxide and acid. The acid forming bacteria were having a feast. I mentioned the problem to friend with whom I was working at the time. He said, “I make a lot of wine at home. Every once in a while I have the same problem. When I do I add a little baking soda. It straightens out the condition right away. The nice thing is it doesn’t leave an after taste. In your case that isn’t a problem!”

Continued on next page

The Benefits of Baking Soda

So I tried the baking soda. It worked like a charm. Within three days I had methane on the way. At a seminar I was presenting a few weeks later, I mentioned this to the group. Baking soda was my “discovery” for straightening out the pH in the digester. One of the people at the seminar sent me a clipping from Business Week magazine a couple weeks later. It was dated June 14, 1976. The headline for the article read “Dosing Sewage With Baking Soda.” It went on to say this was a whole new idea for treating sewage plants; they used to use large amounts of ammonia. The article further proclaimed that soda not only assisted in the more efficient digestion of sludge but increased the volume of burnable methane gas. The most surprising statement of all: bicarbonate of soda “acts as a sort of vitamin for bacteria.” This is the secret for keeping your digester sweet and happy. Just add a little at a time until the pH is just right. Keep adding it periodically if the pH keeps dropping until the acid forming bacteria are no longer producing an overabundance of acid. Don’t be fooled if a lot of gas starts coming. The baking soda itself will produce some carbon dioxide.

The Nature Of Heat

Heat is essential for abundant methane production. In warm climates the process works with little help when the other conditions needed occur. For many of us who live in a cold climate, making methane work is a challenge. One needs to keep in mind that heat stratifies, whether in air or water. Heated fluids are less dense and tend to rise. This natural thermal stratification in liquid is, of course, the very reason why the thermal syphon principle in water heaters works so well. It was this very fact which suggested a digester design with a false floor containing only water. The bottom, the lowest point of the “working” tank, could be heated by a thermosyphon action from some heat source such as solar, or even a little of the gas itself. The heat from the lowest part of this “double boiler” type design would rise through the slurry so that the very bottom of the “working” tank could more easily be kept at the desired temperature in the entire digesting area. Such a tank would most easily be constructed of fiberglass. It could be virtually any size. Next time we’ll think about the barriers to the transfer of heat – insulation – a critical key to any successful operation. This brings us to the question of whether the operation is a net energy producer or an energy consumer.

Al Rutan



Al with the prototype of his Methane Digester

... and the finished Metal Tank Methane Digester on its trailer
(See ESSN July 2005 for internal design)

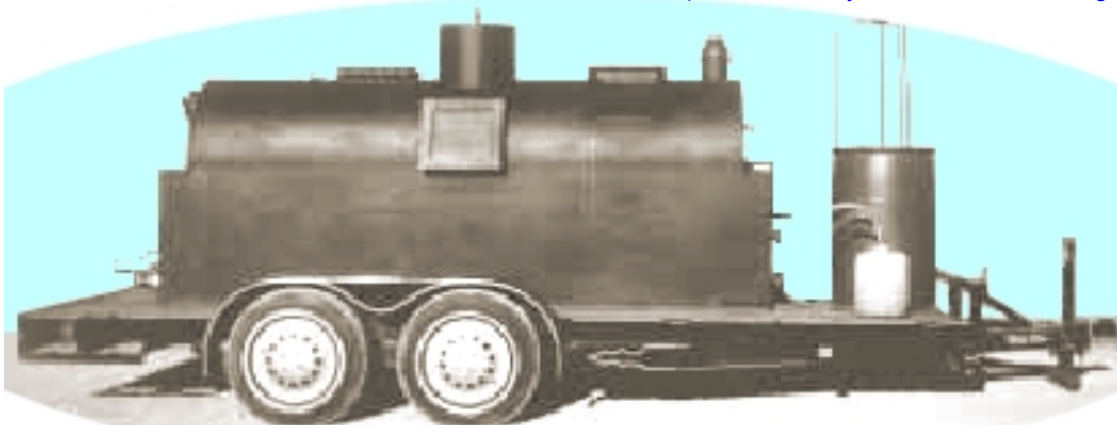


Photo by Al Rutan

STRESS AND ALLERGIES

by Thomas Ogden

Wisdom from the Vet

When I was in college I took a class in veterinary science that was given by the head veterinarian of the university, Dr. Dale Smith. Our university was known for its school of Agriculture and had a reputation as being a "hands on" college. As a result we had large herds of cattle, flocks of sheep, pigs, horses, fowl and so forth. Our vet believed in a holistic approach to animal health.

Dr. Smith had been the university vet for almost thirty years, and his own father had been a vet before him. The first day he told our class, "The most important thing of all for you to be concerned with in animal health is reducing stress. Virtually all the diseases of livestock you will encounter are caused by stress."

He further explained that most genetic diseases had long ago been eliminated with livestock through selective breeding. What you saw instead were animals that were sick because the farmer or rancher wasn't taking care of them properly. They were left outside with no shade in the heat, left with no protection to get out of the wind, stuck in an over-crowded corral, fed a diet too low in nutrients, something that would cause stress.

"The stress causes a breakdown," said the vet, "and then disease of some kind shows up. It could be a pneumonia, cancer, allergies, any number of things, but stress always sets the stage for this disease."

I have long wondered how it was that a veterinarian understood this so clearly and our own doctors didn't seem to pay much attention to it at all. We are animals after all. Stress must affect us just as it does all the other species of animals. I think most of us who have lived with allergies understand that stress can aggravate the allergies. We'll never be able to eliminate all stress from our lives. But we can learn ways to reduce it, and we can learn ways to deal with it. Whenever possible it is healthy to try to see some of this stress as a challenge. If we live active lives, we can expect plenty of stress, and that's all right as long as we don't let it get the best of us.



In Allergy-Free Gardening and in Safe Sex in the Garden I explore how plant sex influences human wellness. If we have female rather than male plants, we won't be inhaling all that male pollen and we won't suffer from it. Allergy-friendly yards and gardens are stress busters.

In addition to decreasing the number of allergens, pollen grains, molds, and fungal spores, there are other things we can do to reduce stress in our lives, in our gardens.

Are allergies just a head-trip?

There is a reoccurring problem with stress and allergies. The problem is one of perception. It is well known that stress aggravates allergies. If you did a computer search using the terms "stress, illness, disease," you might well be amazed at the hundreds of thousands of entries you'd find. For example, on the website healthdoc.com there's an article, "Stress, the number one cause of disease and illness."

Even if the role of stress and illness is not as generally well understood, as it ought to be, it is certainly well documented. Stress contributes to heart disease in certain individuals. Stress also contributes to high blood pressure, high cholesterol, and other cardiac risk factors, and many other negative things as well.

Someone with allergies who is under stress will almost certainly experience worse allergies. The problem here is that too many people mix up cause and effect. Allergies are caused by an allergic response to allergens, to perfectly real substances, pollens, molds, dust, dander, allergic plant saps and so forth.

All too often ignorant people will imply that someone has allergies simply because they don't know how to deal with stress. The implication is that you have allergies because you don't really have your head screwed on straight. This isn't true at all, and actually it is rather insulting. The next step in this illogical progression is that you deserve to have allergies since

Continued on next page

you're bringing it on yourself. The people making these assumptions are, of course, people who don't have allergies themselves. They don't know how lucky they are, nor do they realize how arrogant are their views. Having persistent allergies can become pretty depressing and frustrating and critics are often insensitive to this as well.

Yes, allergies can be aggravated by stress, but then too, so can any other illness be complicated by stress. Allergies are completely for real. A few examples of this: Years ago when I gave my students different flowers to sniff, we quickly found out that a third of the class reacted strongly to bottlebrush pollen. Later, in blind tests with different types of pollen, the same students all again reacted strongly to the bottlebrush pollen. Another example: I have seen people who were very allergic to shrimp. I have seen what happened to them when they ate some food that they'd been told did not have shrimp in it, but that actually did. They immediately became very ill.

When an allergist skin tests someone, often this is done on their back. They can't see the pricks nor do they know which allergen is being tested with each prick of the skin. Their skin will then react with a welt to the ones they are allergic to. If they are re-tested soon afterwards, the results will be the same. Allergic responses are totally for real and this simple fact needs to be respected.

Back to stress. Here are some things we can do to reduce stress in our gardens.

Forget about perfection

We don't need perfect gardens, not at all. Our gardens do not need to conform to some ideal. We should have gardens that please us, and that is what's really important. Think of your garden as your place to feel relaxed, to kick back, to unwind. Good gardens can be great stress reducers.

Garden Design

When you first set up your gardens think about how they will be used. Borrow liberally from good feng shui concepts of energy and harmony. Consider first the function and design gardens that are a pleasure to be in. If you can possibly afford it, get professional advice from a landscape designer or a landscape architect. These people are experts on how to create comfortable, attractive, stress-free gardens. Their advice might in the long run, turn out to be quite a bargain. With some things you do get what you pay for. With a good designer you get a quality



design, one that will long keep you pleased. While you're thinking about how your landscape might look, buy some of the magazines on landscape design and look them

over. See what attracts you. There are many excellent books on landscape design and these too can help you set up a relaxing, enjoyable garden. I recommend you go down to the bookstore, take some time, and look over all the books on garden design. Even if your yards are already landscaped, these books and magazines are still valuable, because you can always make changes. You can always try to improve your garden.

Wild Birds

Wild birds in a garden make it more fun and it is stress reducing just to watch them. All bird feeders add to your pleasure. I especially love those long, porous mesh bags that you can fill with Niger thistle seed. You hang these over a high branch, and the goldfinches will go crazy for it. Quickly the little goldfinches become almost tame. Just watching them feed is relaxing. The larger, more aggressive sparrows tire quickly of trying to feed from these mesh bags, and this conserves the niger seed, which as bird seed goes, is a bit pricey.

Humming bird feeders are great additions to a garden and who doesn't like to watch humming birds? If you can't appreciate humming birds, almost certainly your life has far too much stress in it right now. Hang up a hummingbird feeder, relax, and enjoy the show.



A birdbath can be handsome in the garden, and the birds will enjoy it too. Watching robins splash in a birdbath is good karma. Be sure to keep the water clean. A dirty birdbath can spread diseases among the birds, so hosing it out daily is a great idea.

Wind Chimes

I especially like those bamboo wind chimes but actually, almost any wind chimes add a nice, mellow touch in the garden. I will admit though that there are a few chimes that are pitched too high for my taste. The most important thing is that the chimes sound pleasant to you. Hang your chimes in a spot free of obstructions, where they will catch the breeze. When the wind blows, the chimes sing to you.

Continued on next page

Water

Little ponds, tiny waterfalls, water fountains, all of these are proven stress reducers. Certain sounds irritate the human psyche, car alarms blasting in the night, dogs barking on and on. But other sounds soothe the soul like the sound of splashing water or water tumbling over stones. Placed in the right spot in a garden all these wet additions can do much for the ambiance of the landscape. Fish in a pond can add quite a bit too. More than one new parent has discovered the calming effect that watching fish swim in an aquarium has on their babies. A few goldfish in a pond is attractive too. A little pond also expands the kinds of plants you can grow in your garden. With a pond you can have water lilies.

Today there are many water fountains available and some are not too expensive either. Considering their value for reducing stress, they seem like a bargain.

Lawn furniture

This needn't be anything fancy, but every garden ought to have a nice spot or two to sit and relax. A few garden chairs can make a big difference. A little table is good too. Lounge chairs are by design stress-busters. When I was young we had something called a chaise lounge that rocked and was just plain fun to sit in. More stress reduction. If you have an overhanging branch that looks perfect for it, hang a swing from it. Swinging reduces stress too. There has been considerable research into the importance of rocking babies back and forth. Any mother understands how well this works. Perhaps swinging works the same way?

A comfortable garden bench is a worthy addition to any landscape. Place it where two lovers, young or old, can sit and enjoy the view and each other.

Read a book

Seriously, sit in an easy chair in your comfortable garden and read a book. Turn off the TV and go outside. Commune with Nature. Read a book on how to reduce stress in your life if you think it might help.

Read something on how to maintain a positive, cheery attitude. I find these always give me a boost. But just sitting in the garden and reading a good book is stress reducing. The natural light is good for your eyes and good for all of you. Read a novel if you like. Do sit out in your garden and read. The results are all positive.



Fruit trees



Why not use some fruit trees in the landscape? There is something so basic, so fundamentally satisfying to go outside on a warm summer morning and pick a ripe apricot, peach, apple, or plum. Actually, just watching the fruit develop on the tree is satisfying too. If you're inclined and you turn some of that fruit into jams, jellies, pies, or preserves, that's also fantastic. And fruit trees can be perfectly ornamental in the

landscape. Few trees look half as good to me as a fruit laden apricot tree.

Vegetables

If you have the space consider some kind of a vegetable garden too. There is something about growing tomatoes and string beans that is good for the soul. You certainly don't need a large spot for growing vegetables although it would be great if you had the room. Working in a vegetable garden is relaxing, something very basic. If you have a spot that gets good sunlight most of the day, consider having some sort of a vegetable garden. Even if it is just a little area where you can grow a few tomato plants each year, the pleasure and stress reduction from this can be incredible.

Compost

A compost pile doesn't need to be big or fancy or complicated. You can build a simple wooden box with no bottom and throw all your old banana peels, apple cores, carrot tops, grass clippings, leaves and so on into it. Get some red worms and add them to the compost. They'll multiply like mad and turn all the garbage into wonderful compost. Now and then you can remove some of the finished compost and use it in your garden. Composting is easy, fun, is earth-friendly, and it makes you feel good.

A Barbecue

It doesn't need to be elaborate but if you still enjoy a hamburger or steak or grilled piece of chicken, why not have some kind of a barbecue? Even if you're vegetarian, you can still cook outside on a grill. Bell peppers, chilies, and corn taste great right off a grill. Anyhow, you can get creative. Some

times this provides a good excuse to sit out in the yard while the food cooks. A barbecue can turn an ordinary meal into a little outdoor adventure.

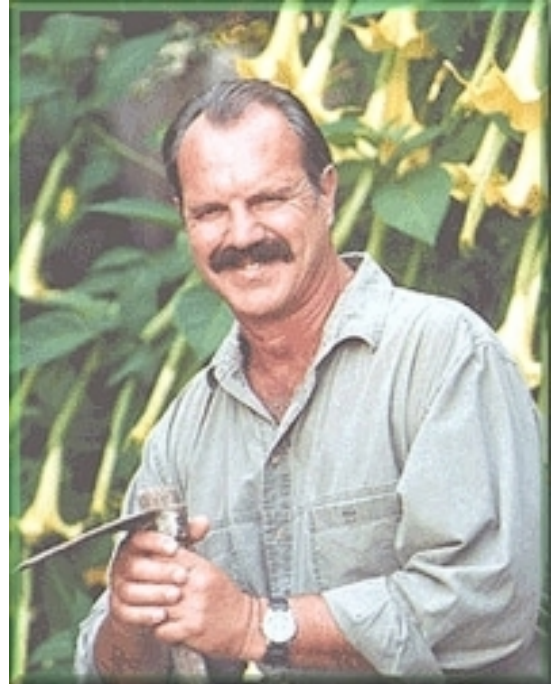
Moveable Pots

I like to have some large pots of flowers that I move around. When they are looking great, I move them up front where everyone can see them. When they are looking ratty, I stick them off on the side of the house to recuperate. I use enough moveable pots with enough different kinds of flowers planted in them, so that I can almost always have something colorful to brighten up any day.

A Lawn

Lawns are a lot of trouble supposedly but really, they are great places for kids to play on. Far too many people get hung up on having a “perfect lawn” and with this attitude a lawn can quickly become a big chore. A perfect lawn ought to be a lawn that you like. If it has three different kinds of grasses in it and a dandelion or two—and that doesn’t bother you, then that’s a great lawn. Lawns don’t need to be huge; in fact excessively large lawns are not worth the effort. But a small nice piece of lawn is a people-friendly addition to a garden. Use lawn grasses that are low-pollen or pollen-free. Privacy

If you like to sunbathe in the nude or just feel like walking out back in your underwear in the morning, you ought to be able to do it without some neighbor looking at you. Front yards can be wide open perhaps, but a back yard needs to provide some privacy. Screens of shrubs or trees can provide this as can a simple 6-foot tall cedar board fence. Having privacy in your garden makes it feel like more of a retreat, a spot to get away from the troubles of the world, somewhere to step right out of the rat race.



The author, Thomas Leo Ogren, is an internationally recognized expert on plant sexuality as it relates to human health. He is author of Allergy-Free Gardening, and also of Safe Sex in the Garden. His work has been reviewed in many publications including Alternative Medicine, Garden Design, Women's Day, Earth Island Journal, Wild One's Journal, New Scientist, Landscape Design, Pacific Horticulture, the London Times, and Garden Gate. He has made numerous appearances on HGTV and was the focus of a recent Discovery Channel episode. He does consulting work for county asthma coalitions, the USDA, and the American Lung Association.

Contact Tom through his website: <http://www.allergyfree-gardening.com/welcome.php>



MAKING ETHANOL FOR FUEL

HOW DISTILLATION WORKS

by Mike Nixon

Raw materials and their fermentation were discussed in the article last month, so we are now at the the stage of being ready to start considering how to extract the ethanol that has been brewed so it can be used as a fuel.

However, there is a first step that must be taken before you may legally do this, and that is to get the necessary permits to distil. I stressed this in that last article, and it is VERY important. You MUST be registered before you start to distil ethanol, or you will find yourself in deep trouble! Advice should always be sought from local authorities to ensure that current application forms are obtained, for legislation is not only continuously changing, but also varies from location to location.

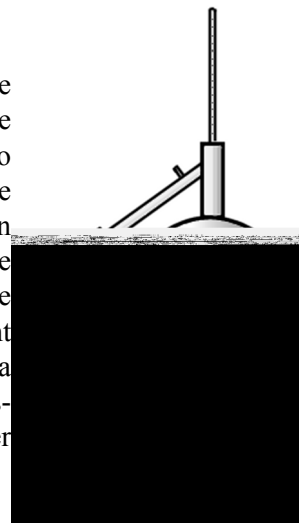
American readers who intend distilling ethanol as a fuel for personal use only may find [this link](#) a useful start. Note what is written there: *Spirits may be produced for non-beverage purposes for fuel use only without payment of tax, but you also must file an [application](#), receive TTB's [approval](#), and follow requirements, such as [construction](#), [use](#), [records](#) and [reports](#).* The main application form 5110.74 may be downloaded from the [TTB website here](#).

And you thought this was going to be fun!

So while you are sorting out the paperwork to get yourself on the right side of the law, let's spend the time usefully by looking at how distillation works. It's pretty essential that you understand what is going on inside any equipment you might make or buy, for without that knowledge you will be most unlikely to achieve good results, and will just be wasting both your time and your money.

Shorn of all scientific gobbledegook it is really quite simple. If you boil a mixture of two liquids that separately have different boiling points (BP), like water and ethanol, then what you get is a vapor that contains a higher concentration of the low BP substance than the high BP substance. So if I had a mixture that contained 10 parts by volume of pure ethanol and 90 parts pure water then I would start with a mix of 10% alcohol by volume (10% abv). Boil that, and condense a sample of the vapor that comes off, I would find that I initially get a liquid that may have an alcohol strength of around 80% abv.

Continue boiling and condensing the vapor, and I would find that the strength of my samples begins to drop. Why? Well, common sense really. I removed more alcohol than water with my first sample, so the strength of the liquid mixture in the boiler got less, and as subsequent samples are boiled off from a weaker mixture, it is hardly surprising that the ratio of alcohol to water in the vapor will also be less.



A simple Pot Still

Eventually, all the alcohol in the boiler will have been extracted, and all I am left with is a whole bunch of plain water in the boiler. At that point, if I had collected all those samples and mixed them together, I would be likely to have a combined mixture that contained around 40% by volume of ethanol and 60% by volume water, ie. 40% abv.

Well, it's a start, but hardly good enough to pour into the gas tank of my car! So I repeat the process, but this time using the 40% abv product I got in the first run. Yup, you've guessed it – I then end up with a product that ends up at around 60% abv.

So, all I need do is keep repeating the process of boiling and collection and I will end up with 100% ethanol. Right?

Wrong!!!

No matter how many times I repeat the process, I will never be able to reach that magic figure of 100%, and there are two reasons for that. The first is fairly obvious – each time I repeat the process my gains in strength get smaller and smaller and, if plotted on a graph, I would get a curve that approaches, but never quite reaches, the maximum strength possible (an asymptotic curve for those who like math). The second reason is not so obvious – in fact, it's downright peculiar!

For reasons that I will not bore you with here, for it takes chem students long enough to get their heads around the

Continued on next page

theory, you can never get a strength higher than 95-96% abv if you distil at ordinary atmospheric pressure. In fact, if I made up a mix of 99% alcohol with 1% water and distilled it, then I would end up with a mixture in the boiler that went down to 95-96% abv, and then stubbornly stuck there! We have a word for this phenomenon, if only to drop it carelessly at the next party to impress people with our erudition (boring old fart!).

That 95-96% abv mix is called an “azeotropic” mixture, and at normal atmospheric it’s as far as you can go. If you want to get up to 100% then you have to distil under quite low pressure, and that introduces so many practical problems that you really don’t want to consider it as an option.

It’s bad enough that the only method we’ve come up with so far to separate the alcohol from the water involves boiling and re-boiling, and boiling again ad infinitum. So we need a method that’s not so laborious and time consuming.

The method that’s been described is called “pot distillation”, for the deep and mysterious reason that to do it you need a pot, and you distil with it (you just knew that it would be difficult to keep up with all this technical stuff, didn’t you?). It’s a method that’s been used for centuries, and is still in daily use. Whiskey distilleries will use nothing else, for pot stills enable them to get just the product they are after.

A more practical method for our purposes is to use a thing called a reflux column. Again, this has been around for ages, and I really couldn’t tell you who first had the bright idea of inventing one. Yet the idea behind it is so simple that it’s brilliant!

It was established on the last page that if you boil a mixture of alcohol and water then you get a vapor that, when condensed, results in a liquid that has a higher percentage by volume of alcohol than the mix it came from. So consider this

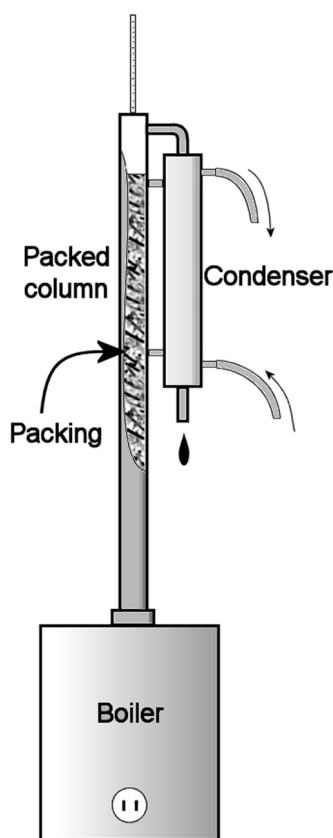
Attach a tube (which we will now call a ‘column’) to the top of the boiler that you put your fermented wash in, and fill that column with porous material that

offers enough surface area for vapor to condense on and be held there, but with enough free space around it to permit free flow of vapor. The name given to such material is “packing” (another imaginative technical term!), and can be anything from marbles or small rocks, to ceramic or metal bits and pieces that have been carefully designed to get the best possible ratio of surface area to volume occupied. In very large industrial columns, it can even be in the form of flat trays with holes in them, accompanied by other bits and pieces like “bubble caps” that force the rising vapor into close contact with liquid that has condensed and pooled on the tray. For fairly small stills, most amateur distillers use the same sort of metal mesh used to make kitchen pot scrubbers, for this is easy and cheap to get and does a very good job.

So what job does it do? Well, picture in your mind a set-up like that which I’ve described – a container in which the fermented brew is boiled, and with all the vapor that is produced being pushed up through a packed column. Let’s start from the very beginning with a cold column, and the first hot vapor that enters it. That vapor meets the cold packing, so is cooled and condensed. In condensing, the vapor gives up the heat that was initially pumped into it to vaporize it – the “latent heat of vaporization”. This is quite a large amount of heat, for it takes far more heat to vaporize a liquid than it takes to heat it up. With water, 540 times as much! So this heat has nowhere to go but into the packing, which rapidly heats up – but not so much that it starts to boil the liquid that has just condensed on it. It reaches a balance when it gets that hot and stops condensing more vapor, so stopping any more heat flowing into it.

Once that occurs, hot vapor from the boiler can rise a bit further and start condensing on cool packing higher up, and in a very short time all the packing in the column has been heated up and is coated with liquid that has condensed from the vapor. “So what?” you might think. “That’s pretty obvious.”

Well, it is, but the consequences are perhaps not so obvious. Remember, the composition of the liquid that first condensed on the packing will be much the same as that first sample I took earlier from my pot still, and will have a very much higher % abv than the liquid mix in the boiler. That means that its boiling point will be lower than the mix in the boiler, for the boiling point of a mix of two liquids with different boiling points lies somewhere between those temperatures. In this case, if the mix in the boiler has a strength of around 12% abv then its BP will be about 93°C, but the mix that has condensed on the packing will have an initial strength of around 80% abv and a BP of about 85°C (these are figures from the top of my head, so please don’t grumble if I’m a bit off the actual numbers).



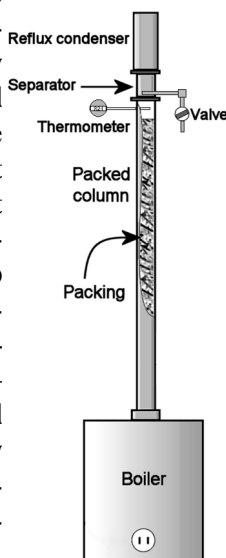
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So there is this newly condensed high % abv liquid sitting on the packing and bathed in new vapor charging up from the boiler. It doesn't take much time before some of that condensed liquid is heated by that new vapor before it starts to boil again, and the vapor that results will have a higher % abv and lower BP than the liquid it came from. The net result is that this new "second generation" vapor rises to a place where it is condensed on packing that has a temperature lower than its BP, so it condenses higher in the column – and this process continues steadily as hundreds or even thousands of "generations" get condensed and re-boiled.

Of course, as more and more vapor from these "new generations" gets condensed onto the packing, more liquid builds up than can be held in place, so unboiled liquid begins to trickle down to packing at lower levels. This is called "refluxing", ie. flowing back, and gives its name to this type of column. What is happening inside is really no different to what happens if you take a pot still and distil and re-distil many, many times. With good packing, a reasonably long column (5 feet say) can produce vapor at the top that is the same as you would get after pot stilling up to 8 or even 12 times. Now this may seem to be the answer we've been looking for – but wait, it's not good enough yet!

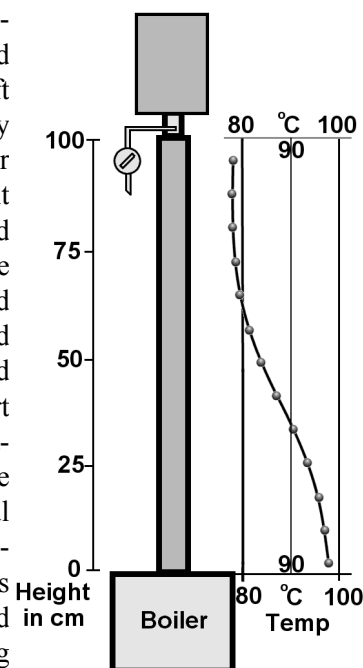
A straightforward reflux column will produce anything up to 90%abv if it is well designed and run properly, but that is a critical 6% below what can be achieved with a simple modification. That modification is to put another contraption on top of the reflux column to end up with what is termed a "compound" column.

We've seen that the "secret" of a reflex column is to recycle material rising in the column by condensing it and reboiling it, all done automatically by the means of using packing. Imagine what would happen if a condenser were to be put on top of the reflux column to condense all the rich vapor that finally makes its way to the top, and to return that as reflux liquid to the top of the packing. The result is rather like water droplets falling onto the top of a hotplate – the refluxed liquid is reboiled almost immediately, and it can be shown that it penetrates the packing by only a very short distance – a few millimeters, no more. The vapor produced by this rises immediately to be condensed again by the top condenser (often called the reflux condenser) and drips down to be immediately vaporized once again.



A closed cycle is therefore established in the top of the column above the packing, in which the number of cycles is not restricted, as it is in the main body of the reflux column. There is therefore no limit to the purity that can be achieved, the top limit being only the azeotropic point.

This therefore introduces the concept of equilibrium. A column is said to achieve equilibrium when nothing is removed as product and the system left alone to settle down to a steady state. If you were to monitor the temperature at different points in the column, you would find it gradually reducing the higher you go, until it reached a steady value at the top – and this steady temperature would extend down into the top part off the packing. The temperature at any point reflects the composition of the material there, and the final top temperature will be the same as the azeotrope of ethanol and water, 95-96% abv, depending on the atmospheric pressure of the day.



Once you have achieved equilibrium, then you can start drawing off product with this composition – the highest concentration of ethanol that can be achieved by the process of distillation.

Of course, there is still a small amount of water present in the product, but it is low enough to ignore if you are going to use that product directly as a fuel. It only matters if you want to use that ethanol to produce biodiesel, where even small traces of water can ruin the process, or if you want to blend it with gasoline.

So what can be done to get rid of that final little bit of water? Well, there are two simple ways in which this can be achieved (and a lot of complicated and expensive ways). The first is by trickling the product you got through dry salt, rock salt for preference as it is coarse and has plenty of space between the grains to let the

liquid trickle down. Water will be absorbed by the salt, but ethanol will not, so what you get out the bottom is almost 100% ethanol. The nice thing about this process is that it is so simple – all you need is to fill a drum with rock salt and let it take its own time trickling down and out of small holes punched in the bottom of the drum. When the salt can no longer absorb any more water, it can be dried in an oven or spread out in the sun to dry, then be re-used – and this can be done any number of times that you wish. Not all the water will be removed, but it is likely that the minute trace that is left will not matter when making biodiesel or gasohol.

The other way is to dry the ethanol is with lime. This is a chemical reaction and removes almost all the water. Ordinary lime [calcium oxide CaO] is mixed with the ethanol in the ratio of around 35 pounds or more to each gallon of ethanol. The lime reacts with any water to form calcium hydroxide [Ca(OH)₂] which is insoluble in ethanol and settles to the bottom of the drum. The liquid is then drawn off, filtered, then redistilled to get rid of all traces of solids to produce a product that can be up to 99.5% abv. Now, as you can see, this is a messy, expensive, and time consuming method, but my main objection to it is that distillation of almost 100% ethanol can be extremely hazardous. I therefore do NOT recommend it, but include it only for completeness. Other methods that employ redistillation with benzene can attain the magic figure of 100% – but your insurance company really doesn't want to know about them!

In any event, remember what was said about azeotropic mixtures. 100% abv ethanol will thirstily absorb water from the air if exposed for any length of time, so I suggest that achievement of 95-96% abv by distillation alone is really the only practical option – which means running an engine on ethanol alone, for then even up to 15% water content can be tolerated and drying will not be necessary.

So now we've looked at what can be fermented to produce ethanol, and how, and got some idea of what happens during the process of distillation. I hope too that those whose interest has been sparked by the idea of making their own ethanol for fuel will also be well down the road towards getting officially approved so they can legally do it. At the risk of sounding boringly repetitive, I cannot stress too much how important that registration is.

The next article will look at hardware – designs of stills that are suitable for this process. Please note, if you have that gleam in your eye, these designs will NOT be suitable for making potable alcohol! Ethanol is not the only alcohol produced during fermentation, and the aim of a making potable spirits is to remove all those alcohols that are harmful to the body, or just unpleasant to drink. In making fuel we will not be concerned with all that, for a car engine will not be concerned much about which alcohol it is burning, so the good news is that both the process and the equipment you need to make fuel are simpler.

Nevertheless, if you want to branch out learn far more about the distillation process, and perhaps add another self-sufficiency string to your bow (albeit nothing to do with ESSN), then you might like to visit the website of The Amphora Society. This gratuitous and blatant advertisement is brought to you with the kind permission of our Noble Editor, Larry D. Barr!

Mike Nixon

THE AMPHORA SOCIETY



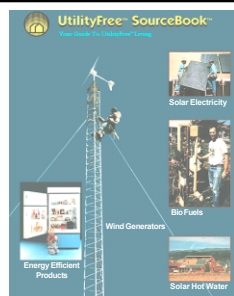
Mike Nixon, together with his close friend and colleague Mike McCaw, founded The Amphora Society several years ago. One of the first things they did was to write a book about distillation that is now widely acknowledged as the clearest book that has ever been written on the subject – so much so that it is now used as a text by many schools and colleges around the world.

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