ESSN
Energy Self Sufficiency Newsletter

December 2005

Off-Grid Living
Biofuels
Hydro
Solar
Wind

PEACE

A Rebel Wolf Energy Systems Publication

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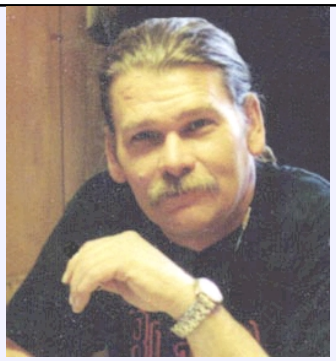
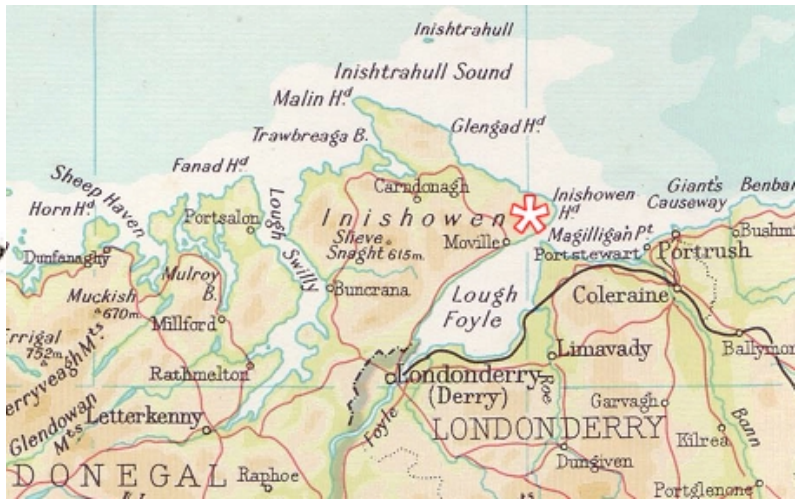


Rebel Wolf Energy Systems

From The Editor's (Traveling) Laptop

by Larry D. Barr, Editor
(DATELINE – Inishowen, Republic of Ireland)



After what seemed an interminable flight over the Atlantic in one of Boeing's finest pressurized aluminium tubes (note my country-correct spelling) – where I discovered how a sardine feels with its eyes open, the pilot finally put our wheels down on the tarmac at Dublin Airport. Then he put them down again, and again . . . It's understandable though. The wind was about 35 knots, with gusts to 50, and he definitely earned his money that day.

For those of you who are thinking, "Aha, our Editor's taking a vacation," belay that thought. I'm actually working. I was invited to speak at Astro-Expo 2005 in Dublin this coming weekend (20-21 November) to introduce the new telescope that the University I work for in Texas has just installed. It will be available to high school students around the world via the Internet, and will give them a chance to do real astronomical research while still in high school.

However, I've over an hour to fill, so I'm going to spend some time talking about some of our science outreach programs too. The things that we do to get students excited about science, even at the first grade level. You'd be surprised how interested and knowledgeable some of those little tykes are about various aspects of the sciences.

But, you know me. I can't open my big, yappy muzzle without talking about renewable energy, so I've incorporated that into my outreach talks to kids. I'll also be sharing some of those experiences with the folks in Dublin. I'll try to remember next month to tell y'all how it went. Maybe even with a picture or two – if our Paste-up Guru will let me have a little extra space for the New Year. (How about it, Mike? Can I use a couple pics next month?) [Larry – all this 'pretty please' approach is confusing for a thicko peasant like me. Just threaten me like you usually do!]

Last night, as my friend Ash and I were sitting in his house overlooking Kinnagoe Bay, watching Sky 1 and sipping Bulmer's (nothing in it but apples and time!), I listened to the wind howling around the house at about 55 knots and it got me to thinking about something.

One of the common objections to vertical axis wind turbines (VAWTs) is that they're woefully inefficient. And I wondered, "Are there times when we don't really need to be concerned with efficiency?" The wind blows here most of the time, and it's been known to get up to 80 knots on occasion. The Foyle Bridge in Derry was closed Friday to avoid a repeat of the articulated lorry (that'd be a semi or 18-wheeler in America) that literally blew off the bridge last year.

Although it's windy here all year around, most of the serious wind comes in the winter when the days are really short (we're at latitude N55°) and some extra electricity could definitely be put to good use. It'd be a rough place to fly a small horizontal axis turbine, so I thought, "Why not just build a helluva-for-stout VAWT and stick it up in the breeze?" I don't really think the efficiency matters when you have winds like this.

I know that the wind purists are cringing at this point and, ordinarily, I would be too. But, if the unit is intended primarily as a backup to grid power, or to just power some of the loads

Continued on next page

in the house, either 12 VDC or via inverter, it comes pretty close to a free lunch – or so it would seem to me.

It just might be worth a thought, and even a prototype sometime in the future. I know that "if I build it, Ash will fly it." I'd like to know what y'all think. Are there times when we can be less concerned with efficiency than simply with the production of energy using renewable sources? I'm sure that some of you are doing that right now, and I'd definitely like to hear about it. Although it's best to optimize our systems for max efficiency, I think it's probably even better – especially in some home-brew systems – to just get with the program and start using renewable energy. Please let me know what you think about it.

Well, the end of the year is upon us. This is our twelfth issue of ESSN and we're looking forward to beginning our second year of publication with the new year. It's been a lot of work that's also been a lot of fun. It's always easy to have fun when you're doing something you love. I hope that each of you found something of use and interest in every issue so far. We'll do our utmost to continue to bring you timely, worthwhile information on renewable energy and energy self sufficiency in the future.

To all of you, from me personally and from the rest of the crew here at ESSN, our wishes for a very happy holiday season and a peaceful and prosperous 2006.

Peace,
ldb

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Circulation Info
ESSN exceeds 23,500 downloads!

Monthly circulation of ESSN, measured by downloads of the PDF and HTML files, continues to rise and now stands at over 23,500!!! 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

OFF-GRID TECHNOLOGY

With thanks to Albert Whale (http://www.abs-comptech.com/aewhale.htm)
for helping to keep this Gem of Wisdom alive

Log On
Makin' the stove hotter

Log Off
Coolin 'er down

Monitor
Keepin' an eye on 'er

Download
Gitten the farwood off'n the truck

Mega Hertz
When yer not keerfull
gitten the farwood

Floppy Disk
Whutcha git from tryin ta tote
too much farwood

Ram
That thar thang whut splits farwood

Hard Drive
Gitten home in the winter time

Windows
Whut ta shut when its cold outside

Continued on next page

Screen
Whut ta shut when it's black fly season

Byte
Whut dem dang flies do

Chip
Munchies fer the TV

Micro-Chip
Whut's in the bottom of the munchie bag

Modem
Whutcha do ta the hay fields

Dot Matrix
Dot Com's name after she got hitched ta Dan Matrix

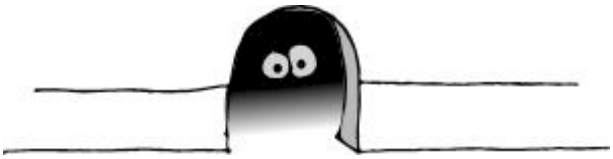
Laptop
Whar the kittie naps

Keyboard
Whar ya hang the dang truk keys

Software
Them thar plastic forks 'n knifes

Continued on next page

Mouse
Whut eats the grain in the barn



Mouse Pad
That's jes hippie talk fer where the mouse lives

Mainframe
Holds up the barn roof

Port
Fancy schmantcie flatlander wine

Enter
Duh! How ya git in the house

Click
Whut ya hear when ya cock yer gun

Double-Click
Whut ya hear when ya REALLY mean bizness

Reboot
Whut ya have ta do right before bedtime when ya have ta go ta the outhouse

More on Methane

Last in a series by Al Rutan, the Methane Man

First published in Home Power #40 • April / May 1994

In previous articles, I discussed a low pressure storage tank, tank insulation, pH balance, animal treatment, and heat retention. I'd like to share some new information I have learned since then. Some things worked and other things didn't, but all facts whether positive or negative are part of the mastering process.

Currently, my methane demonstration is being upgraded. I am discarding the plastic tank that served as a digestion vessel for the last year in favor of a metal tank. Why the change? For several reasons. First, the problems.

Bonding Difficulties

The primary difficulty is maintaining a vapor tight seal between the fill and overflow pipes and the tank. The plastic tank didn't cost much when new, so it was too tempting to pass up. But experience has shown that it was not a good choice. The tank material is polyethylene and the pipes are PVC plastic. While it's possible to weld polyethylene with heat and produce a bond, it isn't something that an amateur can do easily. I attempted to produce a vapor tight seal with various types of glues and epoxies, which was achieved with some success.

But the tank was often moved from one location to another by the trailer on which it is mounted. The sloshing within the tank caused the pipes to break the bond with the tank.

A second reason for replacing the plastic tank is that it is too short; the tank is three feet in diameter and only five feet long. The best proportion for a tank is three to five times as long as the diameter. This rule of thumb became obvious when new material was introduced into the tank at the fill pipe. What exited through the overflow was working nicely, still bubbling like crazy.

Slurry Still Working

The supposed "waste" or "spent" bucket wasn't spent at all, but continued to be active after it had been forced out of the tank. A short tank is truly an inefficient design. The fill and overflow pipes are just too close together. Also, the fill and overflow pipes should not be in line with each other. One should be at either the right or left side of center and the pipe at the opposite end of the tank should be on the other side of center. It doesn't make any difference to which side of center the pipes are placed. But it's important that the pipes at the ends of the tank not be in line with each other. Such a placement of the pipes provides another important advantage — the best position for the stirring mechanism. On the plastic tank, the stirring mechanism was vertical with a crank at the top. After a short time, I learned that this was a poor design for a stirring device. The seal at the top is difficult to keep vapor tight. If the bearings for the stirring mechanism are below the water line, then any leakage is no more than a little moisture, but not vapor.

When the Tank Gets "Cranky"

Also an oversight in the vertical stirring device design was the omission of a bearing point at the bottom end of the shaft. It was left to "float". With the resistance of the material within the tank, the pressure on the one bearing at the crank end of the shaft tended to distort the cover of the tank as the crank was turned.

Ideas that Worked — the Heat Bath

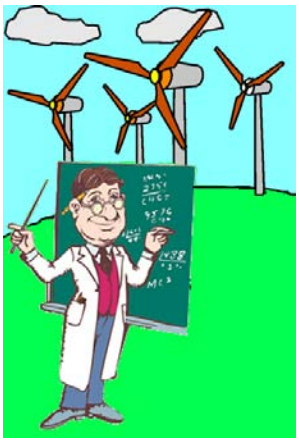
That's the bad news. So what's the good news? The water bath for providing heat to the tank. I originally thought that this would be an effective way to transfer heat from whatever source to the tank. In actual operation, the concept worked even better than anticipated.

Heat is supplied from a two foot square hot water box placed below the level of the water bath. The placement of the source of hot water under the water bath allows the water to circulate via a thermosiphon: hot water rises in a closed circuit of water. The connecting pipes are two inches in diameter — one for supplying warm water and another for the return of the cooler water. The pipes from the hot water box connect to an 18 inch deep metal water bath underneath the tank. The tank is placed on supports six inches above the floor of this water bath.

Al Rutan
RIP

THE WIND BAG

Letters to Dan Fink



From Richard H:
I'd like to buy a windmill to lower my electric bill. My house is 3,000 square feet. How big a windmill do I need to power it? I was looking online and I think I can just barely afford a $2,500, 1kW Bergey that I saw on Ebay.

Hi Richard. This is probably the most common question that I receive. But many people are not aware that there's a whole lot more planning, components, and cost involved in producing your own electricity than simply buying a wind turbine or some solar panels.

You can save lots of expense and grief if you do your homework before making any purchases—LOTS of homework. Google is your friend. Here are some important points to keep in mind while doing your homework:

Tower
Generally, a good tower for your wind turbine will cost AT LEAST as much as the turbine itself. The tower needs to put your turbine at least 30 feet above any obstacles within 300 feet, or your investment in the turbine will be wasted. That usually means a very tall tower, so you'll have to check local regulations and building codes, talk to your neighbors, and possibly get permits. Wind power is best suited for a property of at least 2 acres in a rural or semi-rural area. Since you are thinking making a significant investment of money, you should also check government wind data to see if your location is windy enough for a turbine to be feasible.

Balance of system components
The direct power output from solar panels or wind turbines is not useful for much of anything in a typical grid-connected house. Other components are needed so the energy you produce can be used. These include an inverter, which will probably be grid tied since you are already connected to the power grid. It's an expensive component, about the same price as the wind turbine you were looking at. And with anything connected to the grid, you'll have to get permits and inspections from both the local power company and the local building inspector.

Energy conservation vs. buying a renewable energy electrical system:
Grid power is CHEAP per kiloWatt hour compared to renewable energy. If you use a lot of electricity, such as in a typical American household, you'll have to spend tens of thousands of dollars to bring your power bill to zero. Instead, it's better to first lower your monthly power bill by conserving as much energy as you can, and THEN consider renewable energy.

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For example, it's always cheaper to replace an older, inefficient appliance with a new energy conserving model than it is to buy the solar panels or wind turbine to power the old appliance. Every dollar you spend on conservation will save you $3 to $5 on the cost of a power system, and will lower your payback time.

Some appliances are just not suited to solar and wind power. Examples include electric ranges, electric water heaters and spa heaters, electric space heaters, electric clothes dryers, and air conditioners. Because these items use so much power, the electric system required to run them will be huge and expensive. Better to replace the heaters with gas, and the A/C with a swamp cooler, THEN consider solar or wind power.

You can easily track your home's power usage by simply reading your utility bill each month. It will show how many kW/hrs you used, and what they cost you. You can also buy smaller kW/hr meters that track the power usage of individual appliances and circuits. Commercial wind turbine manufacturers provide estimates of kW/hrs per year output of their turbines at different average wind speeds, so you can get an idea of what to expect coming back in. The comparison of your power used versus what a wind turbine can produce may be very sobering!

So what's up with all the pretty pictures in renewable energy magazines of smiling people that live on just a few solar panels and a small wind turbine? They conserve energy like crazy, and live in very energy-efficient homes. The typical American home uses 780 kW/hrs per month. I use less than a tenth of that — about 70 kW/hrs per month. I'm happy and smiling too, but I also don't leave lights on when I'm not in a room, and I don't leave the TV on when no one is watching it. My major appliancesmostly on Propane, including the fridge. If I were to switch to an electric fridge (it's on my agenda), I'd have to up my system size, and I would choose an extremely efficient model. But I do have a microwave, dishwasher, stereo, TV, and computer network, just like down in town. But I monitor my power status carefully, and I try to conserve every Watt that comes in from solar and wind.

So, let's do some very basic renewable energy math, and assume you are living in a house that uses the national average of 780 kw/hrs per month. Since possible power input varies so much by your location and available wind resources, the following numbers are EXTREMELY rough estimates, factored for both a location that gets good wind (an average wind speed of 12 mph) and only marginal wind (10 mph average). Remember that 'average wind speed' does NOT mean the average only when the wind is blowing, it factors in all those hours when the wind is not blowing at all, or is very light (not enough to produce any power). And also remember that the cost estimates below do include the estimated labor cost of installation by a professional, but they do NOT include any balance of system components, such as a grid-tied inverter, battery backup, permits, etc.

An investment of $15,000 in a 9-10 foot turbine, tower and installation will get you about 80-100 usable kiloWatt hours per month if your average wind speed is 10 mph and your installation is sited well, above all obstructions. If your average wind speed is 12 mph, you can expect 100-150 kW/hrs per month. Ouch, not even close to 780 kW/hrs/mo, and you've spent how much? In situations when lots of power is consumed and all possible conservation measures have been implemented, a larger turbine is the only option that will make much difference in your power bill. A 23-foot Bergey Excel 10 kW machine can make you 520 kW/hrs per month at 10 mph average wind, and 900 kW/hrs/mo if your average wind is 12 mph. Enough to run the average American home! But the installed cost will be around $50,000, and such a large machine will certainly not be allowed by local codes in the city or suburbs.

However, state and local incentives may completely change your payback math. Tax credits from the government and/or mandated favorable buyback rates from the local utility could put your payback time down to just 3-5 years, with profit coming in after that – but only if you are in a rural area with lots of land and very good average wind speeds, with a lot of money to invest.

Finally, here's an excellent place to start your homework: NREL, the National Renewable Energy Laboratory. They have some excellent, free publications both online and in booklet form, and their "Consumer's Guide to Small Wind Power Systems" is printed in separate versions for each state, covering in detail the basics of deciding whether wind power is right for you. Your tax dollars at work!

The Wind Bag
Dan Fink

Continued on next page

From Roger:
Yo, Wind Guy: I'm just starting out experimenting with homebrew wind turbines in my backyard. I don't understand how you get the power down the tower, since the windmill yaws into the wind. Doesn't the cable twist up? Do you use slip rings?

Hi Roger.

Most commercial wind turbines use slip rings at the top to transfer power down the tower. These consist of a rotating ring of contacts, and carbon brushes that ride on the contacts, so the turbine can yaw freely into the wind.

Most home turbine builders don't use slip rings, instead relying on what's called a 'pendant cable.' The problem is, reliable slip rings are very tricky to fabricate at home. And if they fail from adjustment problems, snow, or ice, their failure mode is usually an open circuit. That means the wind turbine has no load on it at all – it's free spinning, and could quickly overspeed in high winds, damaging or destroying the turbine. There is information online about building your own slip rings if you want to try it. Try searching Home Power Magazine's article archives, Otherpower.com's Discussion Board, and Google.

The pendant cable is a very simple, inexpensive, and reliable option instead of slip rings. Some commercial turbines have used pendant cables, too. All of our homebrew turbines at Otherpower.com use pendant cables, and we've had no failures. With the way wind turbines track the wind with a tail vane and furl out of and back into the wind, it's actually rare for the turbine to make an entire 360 degree revolution.

The key to a pendant cable is to install some sort of 3-conductor, sturdy, high-current plug and socket at the bottom of the tower. Then we simply check our turbine wires for twisting every month or so. If they've twisted, we simply unplug the wires, untwist the wires, and plug it back in. In most installations, this will be required only once or twice per year. In areas with very turbulent winds or when using short tower, it might need to be done monthly.

The wire from turbine to the ground should be extremely flexible, with thick, flexible insulation. It will usually be three conductor, since most turbines are 3 phase. We've found that contractor-grade extension cord wire in #8 or #10 AWG works very well. The wire is held at the top by a Kellum Grip, which resembles a Chinese finger trap toy, but made of steel wire. The weight of the wire contracts the grip around the wires, gently holding them without straining or cutting the insulation. The other end of the Kellum is bolted to the turbine frame.

Have fun with your projects!

The Wind Bag
Dan Fink

SUMMER ON ŠIPAN

by Suzanne Ubick

FOOD – GLORIOUS FOOD!

Christmas is coming, and one's thoughts turn naturally to food – well, to be honest, mine seldom turn away from food!

And my thoughts are still dwelling on Sipan, all the more so as I sadly amass daily evidence that backyard farming in the United States is less than publicly acceptable. Farm animals, including even laying hens, are not welcome within any settlement called a town, and some of my correspondents even report that local ordinances are being passed forbidding vegetable gardening. It seems that compartmentalization is reaching a peak as affluence swells like a balloon. I think it's very definitely linked to the housing bubble; as house prices (not values, that's a different animal) soar into the stratosphere and buyers use highly creative financing – including the diabolical interest-only mortgage – panic sets in at the mere thought of somebody next door putting a couple of hens into their backyard. Who knows how many thousands of dollars' depreciation this might cause in the house price – and if you have only one egg, and that in a rather rickety basket, all threats are to be ruthlessly exterminated.

So, rather than brood, I turn to the never-failing comfort of food. These recipes are dedicated to Mike, who specially requested them.

[Thanks Suzanne – Cevapcici (see right) are just great! Try this dip with them: mix together 1 pint yoghurt, ½ cucumber - peeled, grated and drained 1 hour, 2 cloves garlic - peeled and crushed, juice of ½ lemon, salt and ground white pepper to taste, and a pinch of cayenne pepper. Mike]

Last week I made one of my all-time favourites: the Croatian apple tart known as Peta (pee-tah.) Our apple tree is doing us proud this year and I'm taking full advantage of the bountiful crop.

1 cup butter
½ cup sugar
4 cups flour
4 teaspoons baking powder
4 eggs
7-8 apples
Spice to taste

Mix dry ingredients, rub in butter, and add beaten eggs. Mix into a dough. Roll out half to fit a small roasting pan (mine is 15" x 9"). Peel and core the apples, chop coarsely and pile onto the dough, sprinkling with more sugar if desired and seasoning with your favourite spices. Roll out the remaining dough and cover the apples. Make slits in the dough – I got ambitious and cut the word "peta" into the top crust. Bake at 350 degrees Fahrenheit for 45 minutes to 1 hour. Allow to cool, cut into squares, sprinkle with powdered sugar to taste and enjoy.

Being carnivorous, I really love the Croatian version of hamburgers – **Cevapcici**. This is pronounced cheh-vahp-chi-chi.

1 pound ground lamb
1 pound ground beef or veal
1 pound ground pork
1 large yellow onion, peeled and grated
3 cloves garlic, peeled and crushed
2 teaspoons freshly ground black pepper
3 tablespoons hot Hungarian paprika (or use sweet paprika and ½ teaspoon cayenne)
½ teaspoon freshly grated nutmeg
Salt to taste – I use 1 teaspoonful for each pound of meat

Mix all well together, and form into small cigar shapes about 1" thick and 3" long. Roll in olive oil. Broil or bake till done to your personal taste.

Hmm, with Thanksgiving coming up, maybe I could make turkey Cevapcici and pumpkin peta…

Continued on next page

And then there's the basic vegetable dish; take any vegetable or a mixture of veggies, chop finely, and sauté lightly in a little olive oil with a finely crushed garlic clove. Cover the pan and simmer a couple of minutes, till just tender. Sufficient liquid should have cooked out to make the sauce; if not, add water or chicken stock made from good meaty bones, like chicken backs. Thicken the pot liquor with a spoonful of fresh cream smoothly mixed with a spoonful of fine flour. Simmer a few minutes to cook the sauce. This recipe makes spinach into a party dish! Sometimes a boiled potato is mashed into the juice instead of thickening with cream and flour, especially with green leaf vegetables.

Excuse me while I wipe my chin.

Dalmatians devour a lot of fish, cooked very simply. Usually it's brushed with olive oil, sprinkled with a little sea salt and perhaps a little lemon juice, and then broiled or roasted. Large whole fish give the best results; favourites are dogfish, red mullet, and sea bass. Small fish, such as sardines, are gutted and scraped, then fried in olive oil, sprinkled with coarse sea salt and lemon juice, and piled onto a plate. One takes a hunk of fresh bread, wraps a sardine in it, and eats it.

Breakfasts are light; coffee and pastries, with sliced fresh fruit. Our friend Barica (Ba-reet-sa) makes the best priklice (prik-leet-se) I've ever eaten. This is her recipe:

3 cups flour
2 tablespoons baking powder
¼ teaspoon salt
3 tablespoons vanilla sugar
2 eggs
1 cup yoghurt

Sift the dry ingredients together, add the eggs and yoghurt and mix into a soft batter. A little milk may be required – the batter should drop easily from a spoon. Pour a little oil into a cup, and heat a lot of oil in a pot – it needs to be deep. Dip a teaspoon into the oil, then into the batter and drop the batter into the pot. Greasing the spoon gives a nice plump globular "prickle" as we anglicize it. Fry the prickles to a light golden brown, drain quickly on paper towels, and then roll them in powdered sugar mixed with vanilla sugar.

They're even better if you take a cupful of raisins soaked in rakija, and add to the batter before frying. Brandy will do. The alcohol-soaked raisins keep the fried prickles moist and soft for a couple of days, if your willpower lasts that long.

Tomatoes are called pomadore, which translates to "apples of gold." Mostly they're eaten raw, sliced thickly and sprinkled with olive oil and sea salt. They're often accompanied by thickly sliced cucumbers, and sometimes with fresh salad greens. As with other Mediterranean countries, salad greens are usually intensely flavoured leaves of small plants. Lettuce is very much in the minority here. Basil, arugula (rocket), lamb's lettuce, tender baby beet greens, and infant dandelions are mixed and tossed with olive oil and balsamic vinegar.

Olives

Recently, research performed by the Monell Chemical Senses Center in Philadelphia showed that freshly pressed olive oil contains oleocanthal, a substance chemically identical to ibuprofen. Oleocanthal is thought to be the mystery ingredient

in the Mediterranean diet, which though high in salt and fat by United States standards, is proven to reduce the risk of heart ailments, cancer, and relieve the pain of chronic ailments such as arthritis.

Continued on next page

The Monell Center tested olive oils from California and Italy, finding that the highest oleocanthal levels came from Tuscan groves. Croatian oils weren't tested, but even the Italians admit the superiority of the Croatian olive oils and pay high prices for them. I suspect that Sipan oil is as high in oleocanthal as the Tuscan oils, given that the growing conditions are very similar – rocky soil, no irrigation, and the only fertilizer that produced by sheep or donkeys pastured in the groves. Sipan olive trees are very close to the wild stock, producing crops of very small olives – each fruit is about the size of a modest cherry. These intensely black fruits are surprisingly rich in oil. There are trees on Sipan which could well be a thousand or even two thousand years old. The island has its own olive press, now mechanized, and most islanders bring their crops in for crushing. A few older people still crush their olives in the old stone troughs with stone wheels, which is still widely considered to be the best method. Less traditional (and less muscular) growers use the mechanized press – but insist that it be run at very slow speeds so the oil stays cool. Pomace is not usually processed for a second yield, as these connoisseurs consider pomace oil to be more suitable for soap than salad. Good oil must be stored in opaque containers and kept cool if it is to keep its treasure of anti-oxidants and mouth-filling flavour.

Salted olives are made in quantity for nibbles. Olives, sprinkled with coarse sea salt, are packed into clean coarse sacks, filling them about half-way. The tops are tied tightly shut, and the sacks placed on low racks. Heavy weights, usually rocks from the abundant local supply, are piled onto the sacks. Each day, the rocks are taken off, the sacks opened, the olives stirred about, and then the whole lot get tied and weighted again. Squid-ink black juice drips out, taking most of the bitterness of the fruits with it. After a week or so, the olives are shaken out of the sacks into large coarse sieves where most of the salt is removed. Some people store the brined olives in olive oil, some dry them and store them in sacks, and some pop them into the freezer. It's necessary to bite these delightful morsels with caution – they are not depitted. I like olives tossed with a little olive oil and garlic; my husband swears by olive oil and red pepper flakes.

I've just started a new job, which means that my plans for a six-month stay on Sipan in 2006 have been decapitated. You can see how happy I am!

I'm consoling myself with plans to go into austerity mode financially, saving every possible penny for the future, whilst comforting myself with yet another slice of peta.

Suzanne Ubick

AN EASY HOMEMADE ANEMOMETER

BUILT USING A DIGITAL BICYCLE SPEEDOMETER

by Dan Fink

With thanks to Ed Kennel of the University of Washington

Completed anemometer cup and sensor assembly

Sigma Sport Targa digital bicycle speedometer

My Easter Egg Anemometer has been up and flying beautifully for 2 years now. This new design is much easier and quicker to build, but costs a little bit more initially. I learned how to build it during a trip to Guemes Island, WA for Hugh Piggott's homebuilt wind power seminar for SEI. It uses a digital bicycle speedometer to count pulses from a magnet with a reed switch on the anemometer cup assembly, and the speedometer translates this automatically to mph or kph. It also keeps track of your maximum gust, average windspeed, and total wind miles — so it works as a wind odometer too! Very useful for doing wind power site evaluations.

Parts List

- **Digital Bicycle Speedometer** — We used a Sigma Sport Targa because of the peak speed, average, and odometer features. It's available at almost any bicycle shop for about US$25.
- **Anemometer Cup and Hub Assembly** — We used a pre-built Polycarbonate (Lexan®) cup and hub assembly. It's available on our web Shopping Cart. You could use any commercial or homebuilt cup assembly for this. Check out our Easter Egg Anemometer page for details on how to build your own.
- **NdFeB Magnet** — The magnet that comes with the speedometer is a rod shape, and we found it easier to fit a 3/8 inch diameter by 1/16 inch thick disc magnet to the cup assembly rather than the rod. It's Item #75 on our Shopping Cart, and costs only US$0.20.
- **Bearing Assembly** — Many different designs of bearing assembly will work. You want it to spin as freely as possible, so you can get better response and also measure very low wind speeds. For this project, we used the same ball bearing DC brushless PM motor as in our Easter Egg Anemometer, and we removed the coils to make it spin more freely....we just need the bearing for this project. The motor costs only US$2.50. It's Item#2105 on our shopping cart. You could use any sort of bearing assembly you can devise from scratch, just make sure it spins VERY freely.
- **PVC reducer fitting** — 2 inch to 1.5 inch white PVC reducer coupling.
- **3 Machine screws** — #4-40 , 1/4 inch long.
- **Glue** — epoxy, PVC cement, and thread lock compound are needed.
- **Tap** — a #4-40 tap, available at hardware stores.
- **Mounting supplies** — 1.5 inch diameter PVC pipe for mast; telephone or other thin wire to extend sensor wire.

Continued on next page

Assembly

Cut the PVC pipe reducer off with a hacksaw right at the flange, on the big 2 inch side. This gives a wide, tapered rim surface to mount the bearing assembly to. See photos right. Using a file, cut a notch in the flange just big enough to fit the sensor from your bike speedometer. Cut it deep enough so that the sensor can ride flush with the pipe.

PVC reducer fitting

Place the bearing assembly upside down in a vise so it's suspended by the flange. DON'T tighten the vise. Gently tap the center bearing loose from the back using a Phillips screwdriver and small hammer. Or press it out on your drill press. Gently pry the coils out using a flathead screwdriver. Gently press the motor back together — if you go all the way back in now, the motor will bind and not spin freely!

Optionally, you can skip that entire step. However, there will be a bit more resistance in the bearings from cogging, and it will take a couple more mph of wind to set your anemometer spinning. By prying the motor open, you also risk bending and ruining it. So you might want to have an extra available if you try this. The performance difference is very small with the coils left in. Success has been mixed with removing the coils from these motors — it's hard to get them back together so they are tight but still spin freely.

Disassembled motor

Drill out the center of the hub with a 1/4 inch hole. The exact center is already drilled with a tiny hole, so it's easy to get it perfect.

Coils removed from motor

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To mark the anemometer hub for drilling the mounting holes, it's a good idea to cut off 3 small nails with wirecutters, and dropped them point-up into 3 of the small holes in the motor. The hub is then centered around the motor shaft (so it does not touch the shaft) and pressed down to mark the holes (see photo right), then drill your 3 holes.

Nails in Motor for marking hub holes

Now, tap your 3 mounting holes in the motor. Don't push any deeper than the holes already are, or you will distort the metal and seize up the bearing – it'll be ruined. Assemble the anemometer cups onto the hub – they press in – but you have to press hard! Put thread lock compound on the #4-40 machine screws and attach the cup and hub assembly to the motor.

Try it, and it should spin freely by just blowing on the cups. This is essential — it should spin in the slightest breeze, and it should be nearly perfectly centered on the bearing. To seal the top (actually the bottom, after mounting the thing upside down) I simply epoxied a poker chip on there to cover it – a perfect size!

Completed anemometer hub assembly

Next you'll need to install the trigger magnet and rpm sensor switch, then mount the cup, hub, and bearing assembly into the sawed-off reducer.

Mount a small NdFeB magnet to the inner shoulder of the cup assembly with epoxy. Use a file to notch the PVC reducer mount to accept the sensor that comes with the bike speedometer. I simply used epoxy to glue the sensor tightly in the notch. Be sure to test the sensor before glueing it into place!

The range at which it will trigger depends on the location and strength of the magnet. Mine triggered best at about 1/8" clearance between the magnet and sensor. I found the sensor triggered best by pointing the small end of it right at the magnet (see picture right). The sensor wire with the speedometer is only a couple feet long, so I snipped it and used telephone wire to extend it to 20 feet long, so it could run right into the house for mounting the speedometer display inside.

I used small machine screws and epoxy for the mounting. Because of how it's been built, there's a big chance that water could get down inside the bearing assembly and ruin it. So I opted for mounting these anemometers upside down, with the mounting pipe pointed down. The mount can be any design you come up with with 1.5 inch PVC pipe, using Tees, 90 deg bends, anything that fits your mounting area.

Completed anemometer hub assembly mounted in PVC reducer, with sensor attached

Testing and Calibration

For testing the new anemometer, I once again used my truck testing rig. It's simply a pipe mounted in the bed of my pickup that sticks up 6 feet over the top of the cab. Just be careful about overhead power lines and branches while you are testing! Otherwise, the only problem with truck testing anemometers is that even the slightest breeze will completely destroy your test results. You'll need to find an absolutely breezeless day for calibration. If you already have another anemometer that's calibrated (or rent one from the local renewable energy store for a day), you can just mount your new one near the old one and compare the readings.

The bike speedometer uses the measured circumference of a bicycle wheel to calculate the bike's speed, using the number of wheel revolutions per minute as tallied by the sensor mounted ot the bike and the magnet mounted to the wheel. But with anemometer cups, there's a whole bunch of 'slip' involved – the cups to not catch all the wind that goes by – so you can't just enter the anemometer's circumference into the speedometer. That's why calibration is required. With my two anemometers, the offset number entered into the speedometer was 1320 (mm). If your unit is showing a higher speed than the truck or test anemometer, simply increase the diameter that you enter into the computer. If your anemometer reads low, you decrease the diameter. A change of 5-10 mm makes a big difference!

After fiddling with it for a while, you should be able to get very close. If you get widely varying readings, then the breeze is

Continued on next page

Fun Features of the Bike Speedometer

The speedometer computer has some fairly sophisticated data acquisition features, simply available by pushing buttons. You can have it track the maximum speed recorded, or reset it at your leisure. Using the odometer on the Targa unit, you can also track total wind miles – a feature found only on expensive commercial scientific anemometers! It will also track your average windspeed – but keep in mind this is a different figure than 'average windspeed' as rated for a potential wind power site. The bike speedometer ONLY averages the wind ***when the wind is blowing***. True 'average site wind speed' readings take into account all the hours that the wind is not blowing at all. But the information collected can still be useful when designing or selecting a wind turbine.

I hope you enjoy building this project as much as I did. It's a very quick and simple way to build a very accurate anemometer. Thanks to Ed Kennel of the University of Washington for demonstrating this system out on Guemes Island!

Dan Fink

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DISTILLATION

* HOW IT WORKS *

by Mike Nixon

I've had a few people write to me since I posted the articles on making ethanol for fuel, and the underlying question was how does distillation actually work?

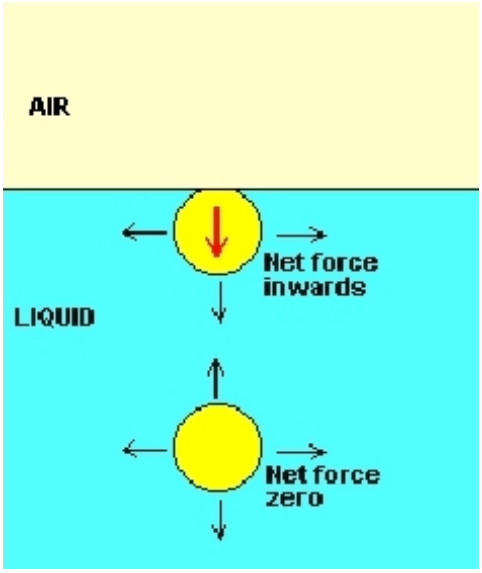
What I did in each of these cases was send them a little article I wrote a few years ago, back in 1999. It's very basic, and leaves out all the math and mumbo jumbo that chemists and physicists like. However, from the comments I got back, it seemed to be enough to satisfy that annoying mental itch you get when you don't quite understand how something works.

So here it is again, warts and all. Experts please note that it is merely a primer, and ATF please note that it was written with potable alcohol in mind – so I repeat the advice I gave when writing about fuel ethanol – get a licence before you try your hand at distillation of ethanol!

Vapor pressure.

Every substance is a collection of molecules held together by mutual attraction. The temperature of that substance is a measure of the kinetic energy these molecules have - the faster they vibrate about their mean position, the higher the temperature. Depending on the temperature and the pressure under which the substance exists, the molecules may pack together tightly as a solid, may pack together loosely as a liquid, or may freely move around as a vapor. These states of matter are termed phases, and the transition from one phase to another is almost invariably sharply defined by temperature and pressure. It may be noted in passing that some substances pass directly from the solid to the vapor phase - they sublime - but I don't think that many reading this will be interested in the behaviour of mothballs!

Having established that there is an orderly transition from one phase to another, the spanner in the works is that both solids and liquids lose molecules to the vapor phase directly - so perhaps we **should** be interested in mothballs! They do this by having enough energy to escape a barrier at the surface caused by the fact that when inside the solid or liquid the attraction of other molecules is evenly distributed in all directions, but at the surface is directed solely towards the body of the substance. This is a potent force manifesting itself in liquids by what we call Surface Tension. It is this which causes the surface of a liquid to form a meniscus against the side of a beaker, or to make globules of mercury scoot around like ball bearings. Many insects depend on it to walk on water!



It takes a lot of energy to vaporize a liquid, far more than to just heat it up, this being the energy needed to overcome the surface tension. Just bear in mind that the ease with which a liquid vaporizes is directly related to its surface tension and that the lower the surface tension the more molecules will be in the vapor phase to contribute to the vapor pressure. Please do not confuse vapor pressure with smell. It is of course true that scents and smells come to us by way of airborne molecules, but a strong smell does **not** imply a high vapor pressure. The strongest smells are those triggered by a class of chemicals called mercaptans. Do not even **think** about accepting an offer to let you smell one of these as the word 'vile' doesn't even come close to describing them! However, it takes very, very few of these molecules to create an incredible stink. On the distilling side, almost odourless ethanol has a higher vapor pressure than the heavier fusel oils that come off in the tails and which smell so awful.

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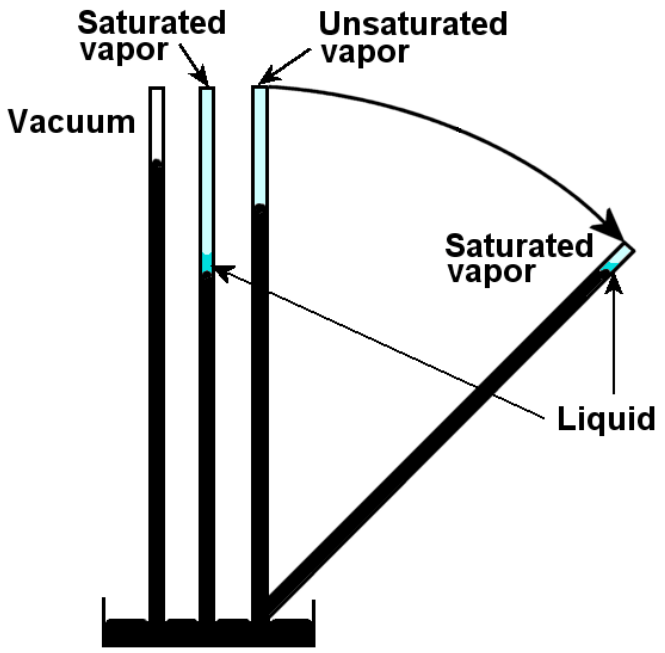
An Illustration of Vapor Pressure.

The vapor pressure of a substance is the contribution these freed molecules make to the pressure of the area surrounding the substance. This may be illustrated in a simple experiment most have seen at school. Take a long glass tube and fill it with mercury. Upend it in a beaker of mercury and if the tube is long enough then it will be seen that the mercury will be held up in the tube as far as the surrounding atmospheric pressure enables it to do - a vacuum being left in the top of the tube (purists - please ignore the vapor pressure of mercury and glass!).



Now introduce a few drops of water into the bottom of the tube. These droplets will float to the top of the mercury column and will be seen to boil rapidly. Eventually, you will be left with a few drops of water floating on top of the mercury column and the mercury column will have lowered by about an inch or two. The lowering of the mercury column is a measure of the vapor pressure of the water at that temperature. Increase the temperature and you will need more water and the mercury column will reduce even more. At around 100^0C the tube will finally be empty of mercury and contain just water vapor. **The vapor pressure of water, or any liquid, equals atmospheric pressure at its boiling point for that pressur**e. Lower the surrounding pressure and you lower the boiling point. Increase the surrounding pressure, as in a pressure cooker, and you raise the boiling point. This may seem to be an awfully long-winded way of going about describing what happens in distillation but trust me, it's necessary to have that picture in your mind.

Mixtures.

Take pure water and you will have a liquid that boils at 100^0C (all pressures from now on being taken to be standard one atmosphere) and has a surface tension of 54.9 dynes/cm 2 (1 dyne = force to accelerate 1 gm at 1 cm/sec/sec). Take pure ethanol and you have a liquid which boils at 78.5^0C and has a surface tension of 21.38 dynes/cm^2 . You may therefore have guessed that the ethanol has a **higher** vapor pressure than the water, needing as it does less energy to release molecules to the vapor. Put some on your hand and feel the cold as it evaporates quickly - now compare that with water.

Now mix the two. Whatever ratio you have chosen, the boiling point of the resulting mixture will be somewhere above 78.15^0C (adding less than 5% water to ethanol actually depresses the boiling point below 78.5^0C rather than increasing it) and somewhere below 100^0C.

Now, to dispel a myth. Do not think that because your mixture contains ethanol that boils in its pure state at a lower temperature than water you can just keep the temperature of the mixture below 100^0C and you will be the delighted recipient of pure ethanol that boils off at a lower temperature! Believe me - I've seen that seriously advanced as the gospel truth!!!

What happens, and this is the crux of the distillation process, is that the mixture boils at some intermediate temperature depending on the relative concentrations and produces a vapor that is a mixture of the two substances. However, not just any old mixture. Remember that bit about vapor pressure and the energy to release molecules from a liquid? The substance with the highest vapor pressure will contribute more molecules to the resulting vapor than will the substance with the lower vapor pressure. So, whatever mixture you started out with, you end up with a vapor that will be richer in ethanol molecules than water molecules. Excellent! You can now condense this vapor and enjoy a good drink, which is exactly what they did in the Good Old Days. Of course, it didn't take long for cunning processors in those same Good Old Days to work out that if you went through the same process again then you would end up with something even richer in ethanol, and so on…

However, and there's always a 'however', what has been described with water and ethanol also applies to other substances, many of which supplied the flavour to the resulting drink but which had lower vapor pressures than ethanol. The result of repeated distillations was therefore more of the intoxicating stuff, but less and less of the tasty stuff. The end result was, as usual, a happy compromise. Booze produced in

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bulk was distilled two, three, or even four times, but then either 'treated' or left to mature (more on this an a moment) before being consumed. This was fine for bulk as there was enough 'float' to tide you over until the good stuff matured. In other cases, where bulk wasn't the prime mover, another approach was taken. The ethanol was distilled and distilled to make it as pure as possible. At the same time, flavours were seeped or distilled from botanicals to form the basis for flavourings. The two were then 'married' as you would a perfume and other substances added to produce the exact flavour and palate you were seeking. In general, the results required less maturation than their bulk cousins, but often benefited from this as well as many subtle flavours couldn't be manufactured in any other way. This approach fitted in well with the monastic life of the church as a) they had extensive knowledge of herbs and the patience to experiment with different combinations, and b) the resulting product was clearly not in the same class as the Demon Drink of the masses. It could even be said to be Spiritual!

Cleaning and Maturation.]

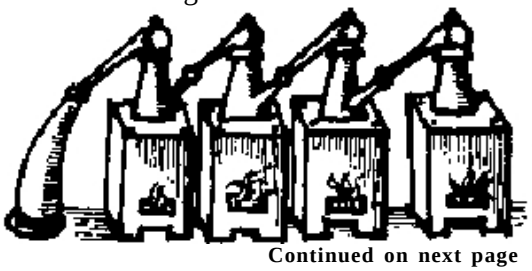
A few more myths to be dispelled here!

Carbon treatment of raw spirit is said to be as old as the hills. No doubt others who have researched ancient matters will be able to fill in the blanks, but it would not be far from the truth to say that after pottery vessels such as amphorae, wooden barrels were used for bulk storage as they were less fragile than previously used vessels. Steel containers are now the thing. Old wine barrels were, and still are in many places in the world, favoured for ageing spirits as they impart a nice colour and subtle flavour both from their previous contents and the wood. However, before using old wine barrels, it would have been prudent to sterilise them as best you could to get rid of all the old moulds that grow apace when the barrels are empty. Fire was (and still is) the quickest and best way of accomplishing this without a lot of work and introduction of strange flavours, and if the resulting carbon had anything to do with the cleaning the stored spirit as well - although not very likely - so much the better. However, we now know a bit more about the action of activated carbon in adsorbing chemicals, both from the spirits trade and from the manufacture of respiration masks. Activated carbons are 'custom built' for their end purpose, generally involving careful selection of ingredients and very high temperature and gas treatment. They work by physical adsorption on the enormous internal surface area of the carbon, typically 1,000 square metres per gram (hard to believe, but true!). Note that it is a physical and not a chemical effect that makes them work. It therefore pays to be very careful about choosing the source and type of activated carbon you use to clean a spirit. Aquarium carbon will **not** do! It is a cheap and nasty mixture of all sorts of quickly charcoaled substances containing bits that may well remove a small fraction of the congeners from the spirit, but also containing bits that will introduce rather nasty trace elements and flavours to your hard won product. Fish won't mind, but you will! Properly sourced activated carbon is on the market now, specifically designed for the purpose of cleaning and polishing spirits.

As for maturing, this has nothing to do with some strange ability of fusel oils (actually, fusel **alcohols**)to 'seep' through the wood and disappear from their confinement (I've heard it seriously said that fusels can do this as they are 'slippery oils'). If this was the mechanism of maturation then uncounted vintners around the world are wasting their time laying down cellars of wine, carefully bottled in glass. Such a Houdini act would be remarkable enough, but maturation is in fact rather more complicated - it's a number of very slow chemical reactions whereby the large organic molecules comprising the 'nasties' are broken down into esters and other flavour enhancing chemicals. It may be that cunning chemists have come up with commercial ways of hastening this process, but in general it remains the most practical and cost effective way of making wines and spirits more palatable. Unless (and there is always an 'unless') you follow the route of the monasteries.

Starting from the beginning, many simple stills were devised - and some from China not so simple - but all sharing the same basic principle: if you boil up a liquid containing ethanol in a pot and condense the vapor then the resulting liquid will contain a higher percentage of ethanol than when you first started. If you repeat this several times then you will end up with more and more ethanol.

The first type of still was called an Alembic, although this properly referred to the cap with a spout that sat on top of the boiling vessel. It worked well, and with variations to make use of modern materials is just what you need to distil botanicals. The second is reminiscent of the moonshine contraptions still used (and raided) in America, but without the cooling 'worm' so characteristic of them.



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The problem with both is that if used to distil ethanol then you also end up with all the other undesirable products - the congeners. Congeners is a term used to indicate a 'family', in this case the family of alcohols that are produced when you ferment sugars to produce ethanol. The lightest of these is Methanol, which because it has the lowest vapor pressure comes through almost in its entirety (also known as the 'heads') and the heaviest include goodies such as propyl, butyl, and amyl alcohols. In addition to the congeners, you may also get acetone (ever tried drinking dry-cleaning fluid?) and ethyl acetate which come off with the heads.

So how do you get rid of them? You can use one of the commercial stills around that are marketed as fractionating stills (and sometimes even as refluxing stills - but you'll be able to judge that claim for yourself better later on) and chuck away the first lot of distillate that comes across. You are fairly sure to get rid of most of the heads that way. You can then continue to distil until you are fairly sure that the nasty 'tails' are coming through in strength, then stop and run all your product through carbon cleaning and polishing. This has the advantages that the equipment is relatively cheap and the process fairly quick. Unfortunately, as we learned earlier in the discussion of mixtures, your middle product is going to be laced fairly heavily with congeners. The carbon will get rid of a lot of these, but it's messy process and it doesn't get rid of them entirely. Let me hasten to stress here that I have nothing whatsoever against these stills -they are a rapid and economic way of distilling if you take the trouble to go through all the cleaning etc afterwards. I would hate to have some of my supplier friends accusing me of taking away their business! However, they are **not** columns, even if they have a little tower on top, and most especially **not** reflux columns.

The Distillation Column.

And now to the crux of this whole thing. How does a distillation column work, and how does it differ from a pot still? This short article will not go into the nuts and bolts of an actual design - for that you need to get "The Compleat Distiller", in which the process is fully analyzed.

For a start, let's go back to basic principles and think about what would happen if you heated a mixture of liquids in a boiler and let the vapor rise in a long column. The first vapor would be richest in those constituents which have the highest vapor pressures - the acetone, ethyl acetate and the methanol. Then would come ethanol, followed by propyl alcohol and water, and with a trace of the heaviest congeners that follow propyl alcohol. This vapor would rise up the column until its temperature dropped to that point when this mixture liquefies. Running down the sides of the column you would now have this richer liquid meeting the hot vapors that are still rising, and they would boil off again, this time with even richer proportions of the first molecules mentioned above, but with a lesser proportion of the last ones. This would continue the higher you rise in the column and what you have is essentially what they have with the big pot stills used to distil whisky.

Now introduce packing into the column. The whole idea is to provide a much bigger surface area onto which the vapor can condense than just the walls themselves, but without interrupting the flow of vapor upwards and the flow of liquid downwards. Much more efficient as the surface area of the liquid is greater and the interchange between liquid and vapor will be faster. It is obvious that the bigger the surface area we can provide then the more efficient the column will be. So what should the packing be? We are looking for something that occupies the least volume yet provides the greatest surface area. Spheres? Well, they have a nice shape and marbles are readily available, but spheres have the least surface area of any shape. Cylinders? A little better, but not far off spheres - unless you drill through the middle and make them hollow cylinders. We now have Raschig rings which are tiny ceramic hollow cylinders that have a much greater surface area than spheres. However, it's not the direct ratio of surface areas that matters so much as the fact that they pack together more compactly than spheres and offer even greater surface area volume for volume. There are other esoteric geometric shapes that have been designed, but in the end it comes down to cost as well. Raschig rings, even if you can get them, are very expensive. However, not to worry - ordinary domestic metal mesh scouring pads or turnings from a lathe all perform appreciably better than even Raschig rings! They offer an enormously greater surface area volume for

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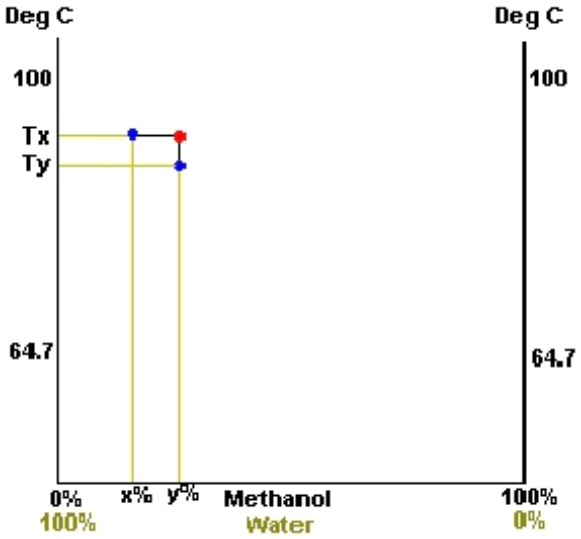
volume, and provide innumerable paths for both vapor and liquid transit. Just make sure that you don't pack them into the column so tightly that these paths are closed up, and for the same reason do not use the fine 'wire-wool' type of scouring pad (the metal mesh pads are quite distinctive as the strands look like miniature coils).

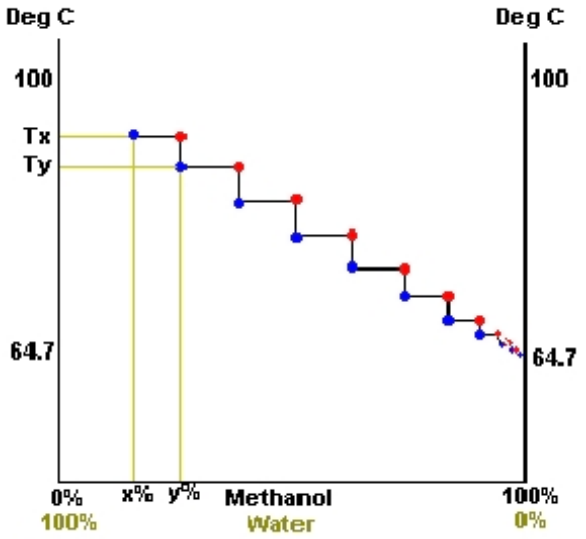
So now we have a long, very long perfectly insulated open-ended column packed with suitable surfaces onto which vapor can condense, and then evaporate from again. Make it long enough, and leave it alone to do its thing. What do we end up with? The first thing to note is that the main difference between a pot still and this column is that gravity plays an essential part. The process of condensing out and running back down the column is termed reflux. The process of constituents separating out, the lightest (and highest vapor pressure) at the top and the heaviest at the bottom is termed fractionating. Lets leave it like this for a moment and look at a little bit of theory to see what we should be aiming at.

Let's start with a methanol/water mixture with X% methanol by volume. The top left blue dot charts the boiling point of the liquid mixture as being Tx^{0}C. The vapor from this mixture contains a higher percentage Y% of methanol as it has a higher vapor pressure than water (shown by the red dot at Tx^{0}C) and this condenses at Ty^{0}C.

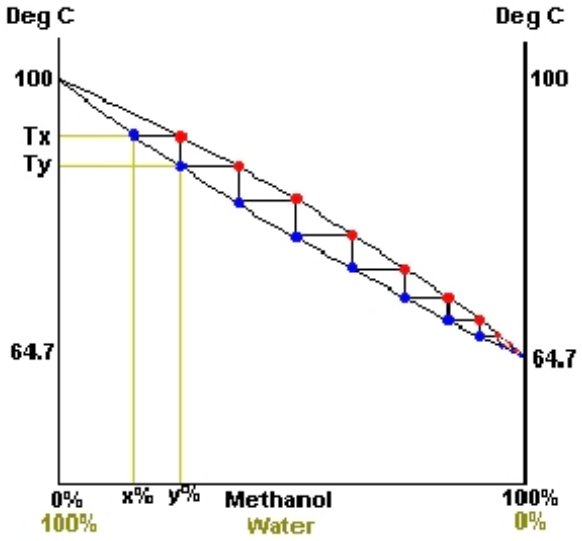


Subsequent vaporizations and condensations are plotted in the next chart. As the concentration of the condensed liquid approaches 100% methanol the boiling point, as might be expected, approaches the boiling point of pure methanol: 64.7^{0}C.

Joining up these dots gives us two curves. The upper one may be called the vapor line. Anything above it is vapor above the boiling point for that mixture, and anything below the lower liquid line is liquid below the boiling point for that mixture.



It is sometimes said that any point lying in between the lines represents a transition phase between liquid and vapor, but a little reflection will show the fallacy of this view. We chose to start at a certain concentration of methanol, but another concentration would have resulted in a similar set of points offset either to the left or right of those shown.



An area where vapor condenses, hangs around and then vaporizes again is termed a 'plate'. It may be likened to an actual plate or tray fitted in the tower. Fractionating towers for oils and fuels are actually built this way.

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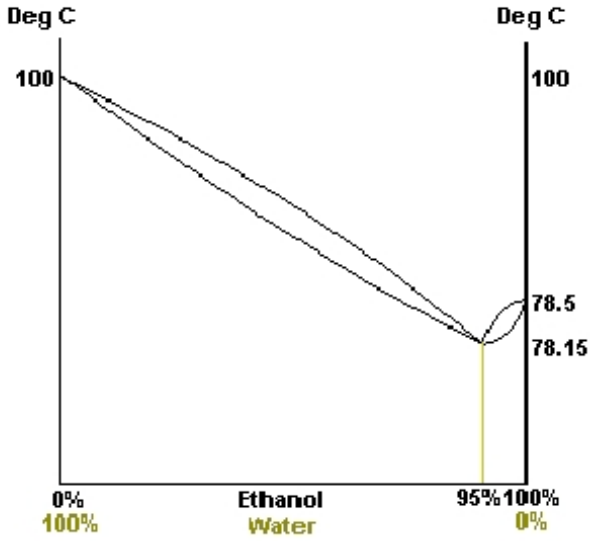
The figures above relate to a methanol/water mixture, and are quite simple. In the case of an ethanol/water mixture we would find that there is a kink in the bottom of the curves. This results from the fact that ethanol and water form an azeotropic mixture when the concentration of ethanol is around 95%. Subsequent vaporization of liquid at this concentration will not yield vapor with a higher concentration of ethanol but one of the same concentration as the liquid. If we started with a mixture that had more than 95% ethanol, then the concentration of ethanol in the vapor would be less and, once again, the system would tend to settle at the azeotropic point



Distillation alone cannot give a concentration of ethanol higher than 95%.

Clever Gnomes have worked out a set of equations which enable you to calculate the number of plates you need in order to achieve such and such a separation between substances, and it turns out that to achieve 95% separation of a water ethanol mixture you need at least 12 plates under full reflux conditions (nothing being taken from the tower, but all falling back on itself). I won't bore you with the calculations here, but those who may be interested may contact me for a full run-down, or search themselves for information on Clausius-Clapeyron and Raoult equations. Start taking stuff from the head of the column and you will need even more plates as you would be disturbing the reflux ratio.

I've described what happens with a mixture of two substances in order to keep the graphs simple. However, the principles that apply to such a mixture apply equally to mixtures of three or more substances. The basic point to keep in mind is that the higher the vapor pressure of a substance the greater its proportion in vapor resulting from boiling the mixture.

Reflux and Balance.

It would be impractical to have an enormously long tower to achieve the separation we require. Fortunately, there is a little trick that may be used to keep the tower to manageable proportions, yet provide excellent separation. Left to its own devices, the tower works by condensing out richer and richer mixtures the higher you go, the condensate running down again until it re-vaporizes and improves the separation. You can hurry this along by making the column shorter and putting a condenser on top. All the vapor that reaches the top if the column is condensed and the enriched liquid is returned to the column. In washing down the packing this liquid, which evaporates and rises again, causes the top of the column to become very enriched with the lightest fraction. The column compensates for this rude interference by compressing the separation between fractions lower down in the column, but this doesn't matter so long as we confine ourselves to extracting from the top.

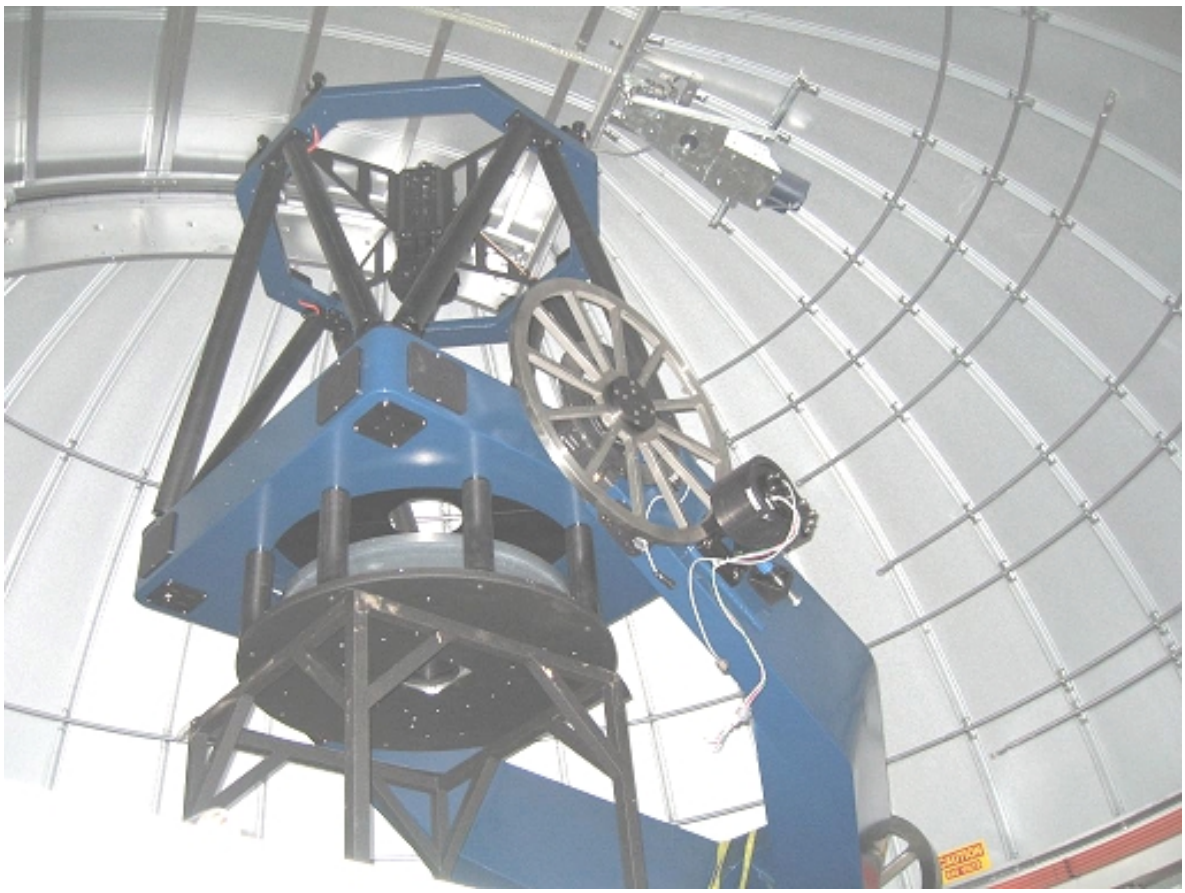
Tried and true practice shows that you can achieve almost perfect separation between fractions by using a tower of about 5 cm diameter and around 1 metre long. The secret is to allow time for the process of wash-down and separation to settle to a stable condition by imposing 100% reflux for about 4 hours. After this time, at least the top half of the tower will be filled with almost pure methanol (at the start), as indicated by the temperatures up the tower having settled down to a stable condition - ie the tower is **balance**d. By bleeding off methanol slowly, maintaining a reflux ratio of at least 10 to 1 (return 9 parts for every 1 drawn off, the ratio being that drawn off versus that supplied by the column) you can maintain this balance and remove all the methanol with only a small 'blur' when ethanol begins to follow the exhausted methanol up the column. The point at which pure ethanol starts being drawn off is obvious from both the increased temperature at the head of the column and the clean smell of the product. This will be 95% ethanol - remember it forms an azeotropic mixture with water and you can't get better than that. Finally, after about 20 to 24 hours (the price you pay for purity), the pungent tails with all the nasty congeners will start to make themselves known.

Conclusion.

So there we are. I hope this article has been useful and not bruised too many firmly held opinions. For those who hold the latter, all I can say is go and check it out for yourselves – but get that licence first!

Mike Nixon

LOOK WHAT SANTA BROUGHT LARRY FOR CHRISTMAS!



This 32″ (0.8metre) Ritchey-Chretien telescope is the real reason ESSN Editor Larry D. Barr spent 11 days in the Emerald Isle recently. The telescope is owned and operated by Tarleton State University in Stephenville, Texas, where he is the Assistant Planetarium Director. The telescope, which is still in its 'commissioning' phase, will ultimately be available to middle school and high school students around the world via the Internet, and Larry was invited to speak at Astro-Expo 2005 in Dublin and introduce the program to Irish educators.

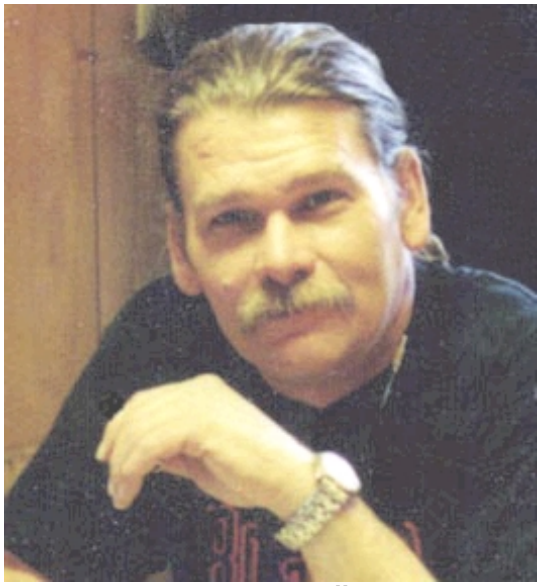
"After I presented our telescope program, which will operate as a part of Hands On Universe, to the Irish astronomers and teachers, " said Barr, "I also shared with them some of the outreach programs we're using to get students excited about the sciences. One of the subjects we use is renewable energy, and it was very gratifying to me to find that there is a lot of interest among Irish educators in sharing RE information with their students and using renewable energy lab projects as another way to teach the sciences and environmental responsibility."

"I know," he continued, "that several teachers so far are using ESSN as a classroom tool and for those who would also like to help their students becomed involved in real astronomical research at the middle or high school level using our telescope, please email me at lbarr@tarleton.edu. We'll also be glad to share our experiences using renewable energy in the classroom."

Larry D. Barr
Assistant Director, Tarleton Science Planetarium
http://www.tarleton.edu/~planetarium/

Maria Alovert
(Girl Mark)

Dan Fink



Larry Barr – Editor

Steve Spence

Laren Corie

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Ghost Writing

Hey folks, do you have experiences you'd like to share with other ESSN readers. Many of you have energy self sufficiency related experiences or information that you'd like to share with ESSN readers. If you're comfortable writing, please submit your article to essn@rebelwolf.com.

On the other hand, if you'd rather not do your own writing, this forumis the place where you can get together with folks who'd like to do some writing with you: http://www.green-trust.org/forum/viewtopic.php?p=1050 . So, if you're one of those folks who wants to work on a collaborative article, just post here that your available and check out the posts from the folks who are looking for you.

I'm hoping to see a lot of fresh content for ESSN come from this forum. We'll be waiting for your posts. All of you!

Peace,
ldb

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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