VTHR Journal

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Issue # 1 January 2007

This month we build a simple green wood chip burner from a tomato can.

Welcome to the first issue of *VTHR Journal,* and happy new year!

If you've contributed thank you very much for your help!

What's Happening

We're currently working on the design drawings for the VTHR green wood chip home heating furnace, and they should be ready this month. We'll post ordering information on the website when ready.

We've also been running the VTHR furnace for three months now an average of two burns per day. Since first firing it has quickly assumed 95% of our home heating needs. We've settled into a routine for the most part of starting a burn after a morning cup of coffee, and a second burn sometime after dinner. Burns last about two hours and are largely unattended, unless there is a reason to record temperatures or observe it in operation.

New Chips

We chipped brush for the first two months of operation using a tractor mounted chipper, but a tip from a friend provided us with 9 tons of very high quality material from a local mill just before Christmas. These chips came directly from mill sawn flitches and board rejects and have a high degree of uniformity. The chips are all oak. The price was $35 per ton, and it looks like it will supply us with the rest of the season's heating needs.

Below are three samples of chips we've tried in the VTHR furnace.

Our chips

The first sample was processed from brush and limbs put through our Jin Ma 6” tractor mounted wood chipper. The chips are cut across the grain and are about 1/4” thick, 1/2” to 1” wide and ¼ to 2” long. They are a mix of what's growing here: beech, black birch, red maple, black cherry and sugar maple and hemlock. These burn consistently and are easy to start. They work well in the VTHR furnace and are the standard by which we judge other fuels.

Sawmill chips

The second sample was obtained from a lumber mill. They are cut along the grain. They are about 1/4” thick 1” wide and 2 to 4” long. The chips are bark free, all oak and clean. These burn fast and hot, unless dampened. Of about 30 trials we have had two partially completed burns, possibly the result of using some chips that were excessively wet from a rainstorm. The oak chips have about 25% higher heat content than the first sample, but tend to waste heat in high exhaust temperatures. We need to work more with these chips to get the most out of them, but they promise to be a very effective fuel.

Tree service chips

The third sample was obtained from a neighbor. The chips were left behind by a tree company and had not been covered with a tarp for over a month. The chips were mixed with leaves, twigs and branches, and were sodden. Two burns with these chips started with some difficulty, but did not complete.

The heat value was lower than the other two samples, but they did burn for 20 minutes to an hour. The problem is probably related to air pockets, uneven air distribution and excessive moisture, all of which cool the burning layer or create hot and cool spots. If critical burn temperature isn't maintained evenly, a burn can go out. Nevertheless, if dried somewhat it is possible to mix these chips with some higher grade fuels and burn them successfully.

Build a Simple Natural Draft Green Chip burner

The Hermes stove. Note the heat stratification and lack of smoke

Because people wonder that green chips actually burn I thought you might enjoy trying it with the simplest natural draft green chip burner I've built to date. It was designed on New Years Eve. It seemed appropriate to warm up a little bit of the future with a little bit of the past. We'll call it a *Hermes Stove* in honor of the Greek god who invented fire.

The funny thing is, it was a lot more difficult to build my first green chip burner over a year ago than it is to build the Hermes stove. But that's because I thought it *should* be possible then, but didn't know it *was* possible. And so I tried a lot of odd schemes, under the influence of the intricate world of combustion literature.

If you play a gas torch on a pile of green chips they won't stay lit when you remove it. Green chips don't burn. But they do in a Hermes stove. Having simplified my first experimental burners to this degree, it seems even more amazing that I can take a non-flammable fuel, and with the most pared-down form of stove, produce so much clean heat without a complicated set of mechanisms, seals, dampers, computer fan blowers, secondary air vents, ceramics, multiple chambers, or insulation. In its most basic form the Hermes stove seems to reveal an essential nature of fire itself. But I should back up a little and explain what happened in January of last year to arrive in the snow with a very hot tomato can in January of this year.

Three simple components. Matches on top help start the embers

By early 2006, with an expensive and failed new outdoor wood burning furnace built over a period of two years from purchased plans (the HAHSA II) I decided that I needed to design something else to heat our house. My hair was died brown in front from the back drafting I'd endured feeding that furnace ten cords of wood, outside, all winter long while tending it every hour and a half. My hair is normally gray.

I'd done a lot of earlier reading about wood chip gasification and had made charcoal before to use in a homemade casting foundry furnace. It seemed like a gasification furnace was the way to go.

Most sources said wood gasification needed dry hardwood or charcoal. But one book briefly mentioned that steam could be injected into charcoal to enrich the wood gas via the well known "water gas" reaction. This reaction splits water into hydrogen and oxygen and partially combines them with carbon to create carbon monoxide, the main component of wood gas.

Reasoning that green wood might have the same effect as steam injection (if I could keep it lit) I began experimenting with the traditional backyard stove builder's arsenal of pipe, tin cans, buckets, stainless bowls, bricks and pieces of sheet metal. I first tried a downdraft gasifier, but because it was important to me that it should run on natural draft, I didn't have much luck keeping anything I'd built burning. Hot air rises of course. The amount of rise is severely limited in a short chimney.

I had also read about about a few camp stoves built from tin cans that used top-lit stratified combustion, sometimes with dry wood fuel or pellets, sometimes with a pressurized assist at the bottom via a surplus computer fan and a 9 volt battery. Sometimes with vertically arranged sticks. Those that used natural draft generally burned incompletely and produced charcoal. The pellet versions often smoked and burned with a yellow flame. The stick versions allowed more vertical airflow than a chip bed would, but still seemed to produce charcoal.

One method that builders dealt with the smoke was to try to mix in extra (secondary) air above the dry wood fuel to burn it in the upper portion of the stove. But this reduces even further the amount of draft assistance from a short chimney. With so little draft it was hard to see how enough air could be drawn through a deep bed of moist chips. A deep bed is necessary because it has to burn for a couple of hours, to be useful in a full-sized home heating furnace. So I favored a n unvented design.

It also occurred to me that the reason for the smoke in small dry wood burners was that the fuel was burning too fast for the air available from the bed. It seemed that if I could slow down the combustion rate, the amount of oxygen available would be sufficient to burn the fuel cleanly.

Eliminating secondary air vents would increase the air flow from beneath allowing a deeper bed, higher surface temperature and lower bed temperature. Again it seemed that green wood might solve all of the venting, mixing, and draft problems by burning more slowly, if combustion could be sustained. I needed enough draft to keep the top layer of the fuel incandescent in order for all of the necessary gasification reactions to take place.

After several trials, the first successful natural draft green chip burner was constructed from a short ceramic flue liner and a tall stovepipe chimney with no secondary air admission. It was hard to light, but I was able to get remarkably clean stratified combustion on first try. It was a great feeling and awe inspiring to watch the pure heat rippling silently out of that burner in mid-winter with no visible exhaust, for as long as an hour. But the fun was short lived. The extreme heat differential in this type of combustion cracked the chimney liner after only two trials. The difference in temperature at the line of combustion can easily be a thousand degrees in one vertical inch of furnace wall. I cemented the pieces together a few times and then began designing and testing more permanent chambers. Eventually the after much work with combustion chamber and hot water heat exchanger trials the VTHR furnace was designed and built.

Our little Hermes stove here is a miniaturization and simplification of the early experiments, and small enough so that anyone can build it. It is a lot easier to load and light however than those early burners. Ready to try it?

The burner can, inverted to show base holes

Hermes Stove Materials List:

1 Large Tomato Can
1 Black Iron Pipe Nipple, 1-1/4” x 8”
1 Black Iron Pipe Flange, 1-1/4”
4 Flat Head Screws, 1/4” x 1" or shorter
4 nuts, 1/4”

Construction Sequence:

1.) Open the can at one end and make some spaghetti sauce with the contents.
2.) Peel off the label and wash it out.
3.) Using a church key style can opener, punch about 11 holes in the sides near the bottom.
4.) Screw the pipe nipple into the pipe flange.
5.) Insert the screws into the pipe flange and tighten the nuts.
6.) Set the flange on top of the can. The screws and nuts should clear the can sides on the inside.

A few notes about safety. *This is an experimental stove. Building and trying it is entirely your responsibility. Use common sense. It will get hot. Only run it outside on a non-flammable surface. Don't touch any parts until completely cool. The can is probably coated with enamel inside and will smoke on the first burn. Don't breathe it. Don't use galvanized pipe fittings, the zinc may vaporize. Don't use gasoline to try to start it. Keep a bucket of water nearby.*

You can make your own chips for this small stove

Firing the Hermes Stove

> "Hermes began to seek the art of fire. He chose a stout laurel branch and trimmed it with the knife held firmly in his hand: and the hot smoke rose up. For it was Hermes who first invented fire-sticks and fire. Next he took many dried sticks and piled them thick and plenty in a sunken trench: and flame began to glow, spreading afar the blast of fierce-burning fire." - *Homeric Hymn 4 to Hermes 110*

1.) You probably don't have a chipper or suitably small chips, but if you have some green brush and a pair of garden shears, the furnace is small enough to cut your own chips by hand. Hardwoods are best. Dry wood will smoke. Twigs pencil diameter cut to about 1/2' long are good.

2.) Fill the can to about an inch and a half from the top with green chips. Add a layer of dry wood chips, and a small handful of wooden kitchen matches to the top. Add a small slightly crumpled square of newspaper on top of this -- not too big.

3.) Light the newspaper and cover the furnace with the flange/chimney.

4.) There should be smoke at first but if the fire takes, it will eventually clear up and begin burning in earnest. The aim is to get a some hot wood embers lit quickly across the surface of the chips.

Problems: If this doesn't work, and you have some small red hot embers from another fire, you can drop them down the chimney, and that almost always works. It's the embers above the the fuel that powers this reaction. Likewise if you drop more fuel down the chimney, you'll get smoke and will put the fire out. You can restart a smoking fire by adding an ember. It will clear immediately.

In the past, I have wet the newspaper with charcoal starter before lighting. Be careful. Don't pour starter deep into the chips, because you only want the top surface to burn. Of course, never add charcoal starter to the furnace after lighting -- even if it appears to have gone out.

You should be able to achieve a good clean burn several minutes after lighting that lasts nearly a half hour. Smoke may mean too dry wood, or the burning of can or pipe coatings. You will see the stratification move down the outside of the can during the first burn.

Let us know how your stove works out. Try a variety of chips and see what burns best. Good luck in the new year!