Thermo-Biopile

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Good luck,

Jeff

Abstract: A compost or possibly a humus pile was constructed to explore the possibilities of utilizing the heat generated from this process to heat a building. The building was a work shop that needed to be kept above freezing temperature or higher during late fall and winter. It did work to some degree but further work needs to be done. With the first version there was a problem separating the water pipes from the compost/humus at the end of it's life cycle. The second version replaced the water pipes with a water tank and added a second source of heat thus a hybrid heating scheme using gasification.

Links:
Email
Youtube
Bioenergy

Photo 1

Background: In the 60's to early 80's the late Jean Pain worked on an amazing scheme where by he was able to collect compost heat, generate biogas and humus. The biogas fueled his truck and generator. The compost heat was used for domestic needs. Humus was utilized in his garden farming explorations with excellent results. Personally I have no idea how he had the energy to do all these feats but surly if it wasn't for his wife, who wrote his book entitled “The Methods of Jean Pain or Another Kind of Garden” he could never have achieved such heights.

Photo 2

Professor Henri Stehle, Laureate of the Institute, Doctor-Engineer, formerly Director of Research at the National Institute of Agronomical Research (NIAR) , wrote the glowing preface/letter of Pain's book. A small quote follows:

“In this text, which has been written by his daily witness and collaborator of every minute, including the “report”, one will see how well he has succeeded. He has gone about it in no ordinary way but his classroom has been the garigue, the forest, the garden and the meadow. First of all he has observed, pondered, experimented, read the great books of Nature, following the example, though unconsciously, of the Templiers and the Cistercians, and then, but only then, has he sought the explanations in science, sometimes in European science, sometimes in that of the New World or of the sages of India.

From the practical application, from the experiments and the results he has recorded, he has then gone back to examine the causes; from the practical he has moved to the theory, up from the land and the

forest towards the sky and the light of photosynthesis.

If the path Jean has trodden is not the traditional one, nor the one which all men tread, who is to complain? ”

Henri Stehle

Photo 3

Photo 4

Photo 5

Photo 6

Design Overview: The Thermo-Biopile's design intent is to provide heat and compost or better yet humus. The reactor core is comprised of switch grass bales and wood chips. A layer of bales with wood chips sandwiched between. Also in some of the wood chip layers are water pipes to harvest the heat generated. There are also piping to provide water and air.

In photos 1, 2, 3, & 4 you can see the wood chips being added between the layers of switch grass. These wood chips are NOT of the same quality that Pain used. These are much courser. The plastic tubing is also placed in the wood chips.

Photo 7

Photo 8

Photo 9

Photo 10


Photo 11

Photo 12

A front end loader was used while the pile was within reach. Especially for the wood chips. The wood chips would heat up to about 140 F within a day or two. Mostly pine was used to produce these chips.

Although they quickly heated they also cooled down in a relatively short time. Unfortunately I no longer have this data. An elevator was used to help construct the pile. See photo 5.

The plumbing to and from the Thermo-Biopile is insulated with switch grass and wrapped in black plastic. Also kept off the ground by using barrels and wood boards. Interestingly this work vary well. See photos 6, 7, 8, 9 & 10.

Photo 13

Photo 14

Photo 15

Photo 16

The layers of hot water pipes were connected in series. Garden soaker hoses were used to add moisture to the Thermo-Biopile through the winter. See photos 4, 3, & 8. In addition to moisture (water) sugar solutions and garden fertilizer (Miracle Grow) was tried. In addition to liquids being introduced via the soaker hoses air was also injected with the use of an air compressor. When ever anything was added to the Thermo-Biopile, water, sugar, air or fertilizer, there never was any measurable increase in temperature. It seemed to perform slightly better if let alone.

In order to retain moisture and possibly some heat the pile was covered with a plastic tarp. Later the tarp was removed and no reduction in heat output was measured. See photos 9 & 10.

In photo 12 you will find the telemetry device. The receiver is the left device and the transmitter is on the right. The receiver is placed in the nose of the Thermo-Biopile and senses temperature and humidity. This perforated pipe can be seen in photos 5 & 7 but is not obvious, look toward the top. The receiver also has a clock that gets automatically set from a far away low frequency radio station. See photo 12.

In photo 13, you can see that the Thermo-Biopile is at 102.2 F and the humidity is 55%.

There were also a number of temperature probes made from thermocouple wire with the ends welded together with the Henrob 2000 in order to make a junction. Then this wire was placed in a plastic tube with the end and junction epoxy sealed. Next these assemblies were placed at various places and depth in the pile. I did keep a record of the findings but unfortunately as the years passed by these records were lost. See photos 14 & 15.

Photo 16 shows the paint pot that was used to inject the additives into the pile. These solutions or just water was also heated with the below burner so not to shock the pile.

A byproduct of the Thermo-Biopile is compost or better yet humus and below is another quote from Pain's book were he/she quoted Mr. Waskman. So what did I do with the compost or humus from this experiment? Well, that's another two stories.....

Copied below, from Pain's book, is a quote from Waskman (Nobel Prize winner, 1952) regarding humus:

HUMUS: " A complex mass, dark brown in colour, consisting of amorphic substances which originate in the decomposition of plant and animal waste- matter by micro-organisms, in aerobic and anaerobic conditions, usually found in peat-bogs, soils, composts and humid cavities. Chemically, HUMUS is made up of various components which have resisted to a more advanced state of decomposition; substances produced by the decomposition of compounds; decomposition either by hydrolysis, or by oxidation, or by reduction; and from various compounds of synthesis from micro-organisms. Humus is a natural substance; it is a complex entity comparable to plants, animals and microbian substances [that] go into its make-up. HUMUS possesses specific physical, chemical and biological properties which set it apart from all other natural organic bodies. By itself or by interaction with certain mineral components of the soil, HUMUS forms a colloidal compound, whose components are linked together by force of contact; this system can adapts to changes of conditions, reactions or humidity. The numerous activities of the micro-organisms of the soil play a large part in this system."

Properties as follows:

- "HUMUS is dark in color, brown to black. "
- " HUMUS is practically insoluble in water, although part of it may go into a colloidal solution in pure water; HUMUS dissolves to a large extent in weak alkaline solutions, especially at boiling point, leaving a dark-coloured extract, a substantial part of this extract precipitates when the alkaline solution is neutralized by mineral acids. "

- " HUMUS contains a higher proportion of carbon than plants, animals' bodies or microbes, the percentage of carbon lies somewhere between 55% and 56%, and often reaches 58%. "
- "HUMUS contains a great deal of azote, often between 3% and 6%. The percentage of azote can often be inferior to these figures; in the case of marsh peat at high altitudes, it can drop from 0.5 – 0.8%. This percentage can equally well be higher, especially in layers underlying the soil, where it often reaches 10% or 12%. "
- "HUMUS contains carbon and azote in relative proportions of about 10 to 1. It is thus particularly indicated for coastal ground. The proportions varies a lot according to the nature of the humus, the stage of decomposition, the nature and depth of the underlying soil, and the climatic conditions and various other conditions of formation. "
- "HUMUS is not static, it changes, since it re-forms over and over again from plant and animal waste-matter, and it is constantly changing through the action of micro-organisms."
- "HUMUS provides the source of energy for the development of various groups of micro-organisms, and during decomposition gives off a continuous flow of carbon dioxide and ammonia. "
- "HUMUS is characterized by its great capacity for exchange and combination with the other components of the soil, its capacity for water- absorption and expansion. It is also characterized by other physical and physicochemical properties, which make it one of most precious parts of the substratum, bringing life to plants and animals alike. "

Waskman (Nobel Prize winner, 1952)

Conclusion: It did produce a usable amount of hot water for about two months but once the dead of winter set in about all it did was keep the water pipes nicely above freezing. We do have harsh winters in this area so it may do better in a warmer climate. On the other hand, even today, I miss those two month of trouble free and continual source of heat. During this experiment I had a heat back up but because of the time that passed I don't recall what that regime was.

With this design one should not under estimate the burden involved with dismantling the pile after it completes it's life cycle. *It's too difficult to separate the compost from the tubing.*

In a nut shell this exact design is not practical but provided experience and knowledge for the next version which is covered, below, in this document. It also was the impetus for Fuelage, biogas and garden farming experiments. Hopefully I'll find the time to wright documents covering those experiments.

There is another person by the name of C. Johnson (Physicist) that has a rotating drum compost heat reactor that shows promise, at least that his claim. See his web page below:
http://www.mb-soft.com/public3/globalzc.html

I do believe that some kind of reactor is the proper path. All the variables need to be under control and a reactor scheme just might be the answer.

Below is the second version:

Tank: For the water tank, having to use what I have or within a small budget, an old converted truck water tank was pulled from my stock.

Before loading and transporting I knew that there would be some work involved patching the rust holes but it did, to a fair degree, hold water before being removed from the truck years ago. But, after some patching and evaluation it became quite apparent that it was no longer a valid water tank! See photos 1a, 2a, & 3a.

Photo 1a

At this point there was no other choice but to use another 2000 gallon tank that was being used in conjunction with a different application. In photo 4 you can see it set in place.

Combustion Tower: At this point there was the problem of what to do with the rusted out tank. It was a project to get it moved over and I really didn't feel like repeating the effort of returning it so it was integrated into this project after all. It was set vertically and two doors, one above the other, were fabricated. Below the burner and or gasifier. Above was the fire tube boiler fabricated from a 55 gallon drum and exhaust pipes, as seen in Photo 5a.

Photo 2a

Photo 3a

A round hole was cut into one of the bulk heads to allow the burner to communicate with the boiler. This bulkhead also supported the boiler. See photo 7a.

Mr. Charcoal and the Twister Top were used in the Combustion Tower but neither will be discussed in this document. The Twister never made it into the Combustion Tower because of reliability issues. Also, just burning switch grass bales were tried.

Above in photo 6a are the doors being cut out of the tank material. The first cut is vertical were the hinges will be welded. After this cut the barn door hinges were welded first to the tank then after applying down pressure, simulating the weight of the door, the door end of the hinges were welded to the door thus minimizing door sag. Next the remainder of the door was cut. Also, door snubbers and latches were fabricated.

Photo 4a


Photo 5a

Photo 6a

Photo 7a

Photo 8a shows Mr. Charcoal and the boiler installed. The lower bulkhead had to be removed in order to facilitate Mr. Charcoal. The very top bulkhead was left intact except for a hole to allow the smoke stake to pass through. Cement was poured on the bottom to add some ballast and a bit of a refractory when switch grass bales were burned in this chamber.

Later a flue gas bonnet was added on the top of the boiler. In addition a shroud was also constructed around the boiler to help route the flue gases. The boiler is a zero pressure boiler.

System: Above, in photo 9a shows the hardware set in place. A pair of circulation pipes were insulated and buried in the ground from the heat source (Thermo-Biopile) to the heat sink (building). This pair of pipes was connected to the tank only.

There was a circulation circuit between the boiler and tank motivated via a small circulation pump. Since the boiler was used only once a day for about two hours or less and there was little insulation in the Combustion Tower and minimal insulation on the circulation pipes a drain back scheme was utilized. When the circulation pump shuts off the water in the boiler and pipes simply drained back into the tank to avoid freezing.

Photo 8a

In photo 10a you can see the pipes going to and from the boiler. Photos 10a, 11a, 12a and 13a show the Thermo-Biopile in operation. Only chopped switch grass was used for the pile.

Conclusion: It was much easier to remove the compost/humus now that there was no longer any pipes intermingled with the pile. Performance of the pile was about the same as version 1. Life has a way of getting in the way and performance data was lost over the years including boiler performance.

The chopped switch grass tends to dry out in the center of the pile and of course that's the location of the water tank so as time goes on less heat makes it's way into the tank. This seemed to hold true for other smaller chopped switch grass piles. There is an outer wet layer, about 8 inches, that tends to shed the rains. The inner part of the pile heats up and expunges the moisture leaving the center relatively dry. Possibly this could be a scheme for storing chopped switch grass outside or possibly this was just a fluke.

Photo 9a

Although it's nice to have about two months of steady trouble free heat the amount and degree is not beneficial enough to duplicate this exact

scheme, in regards to the pile. I tend to believe that a reactor scheme, were all variables can be controlled, would be a saner approach.

The Combustion Tower was severely lacking in sound engineering but did seem to be of interest.

The boiler did OK but exhaust pipes are expensive and it's much cheaper and less timely to find a discarded or used oil fired boiler. Many people, at this time, are replacing their older oil fired boilers

Photo 10a


Photo 11a


Photo 12a

Photo 11a

for clean burning propane fueled boilers at least in this area. It's relatively easy to remove the boiler from the unit. The drum boiler held up well when in use but during off season it tends to deteriorate rather quickly.

Above is a photo of Mr. Charcoal at work inside the Combustion Tower.

On the right and on the next page are three additional photos of the boiler.