Constructing an Adobe Kiln for Making Charcoal

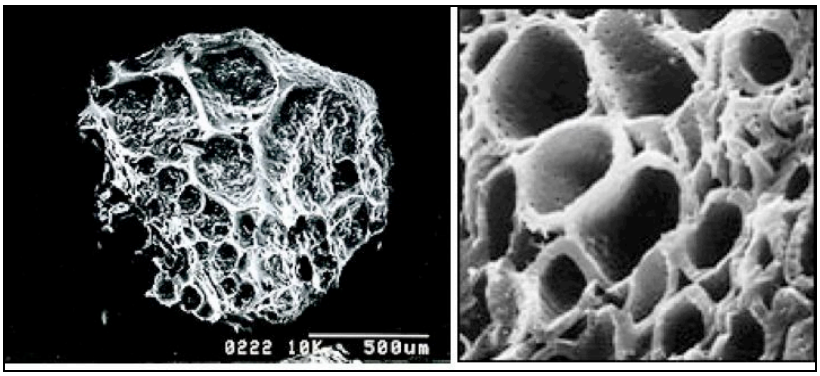
By Josh Kearns
Fall 2007

The prototype charcoal kiln described here has been developed for an organic farming community in northern Thailand. The Pun Pun Organic Farm and Seed Center, the Panya Sustainable Living Project and the You Sabai Thai Cooking School form a community of about 50 people located 60 km north of Chiang Mai city. This community's mission is to provide a working example of locally self-reliant, sustainable living through permaculture, organic farming, seed saving and natural building.

A year-round source of freshwater is available to the community from a network of irrigation canals fed by a nearby reservoir. However, prior to consumption this water must be treated by charcoal filtration for possible contamination by fertilizer and pesticide runoff from neighboring agricultural zones afflicted by conventional (i.e. agrochemical intensive) farming practices.

The US EPA, the World Health Organization and several academic studies identify granular activated carbon (GAC) as the best available technology for the control of many agrochemicals and synthetic organic chemicals in drinking water.[i, ii, iii, iv] GAC is made from charcoal, by "activating" it using a variety of physical or chemical processes designed to greatly increase the microscopic surface area of the material. A few grams of industrial grade GAC, for instance, can have a surface area equal to a football field. It's this highly reactive surface area that attracts dissolved contaminants and binds them electrochemically.

Electron microscope image of granular activated carbon. The grain on the left is about 1 millimeter across. The right image is a close up of the pore spaces.



Charcoal itself is made by pyrolizing – heating in the absence of oxygen – wood or other organic matter such as coconut or rice husks, nut hulls, peat, etc. While it isn't possible to produce high-grade activated charcoal without an

industrial process, charcoal with a lower, but still significant, reactive surface area can be readily produced in earthen kilns. Researchers have observed, for instance, a low-grade char produced by burning wheat straw to be about one-third as efficient as industrial activated carbon for adsorbing particular dissolved pesticides. [v]

We have constructed an adobe kiln at Pun Pun Farm in which to make charcoal. Adobe bricks are made by mixing mud, roughly 80 percent sand and 20 percent clay, with fibrous organic material such as chopped straw or rice husks. (In Thailand we use rice husks as they are superabundant.) This adobe mixture is poured into wooden molds and the bricks allowed to harden in the sun over about a week's time. This kiln design requires about 80 bricks.

Making adobe bricks.

The bricks were stacked in an approximate beehive shape about 1 meter in inner diameter and mortared together with a similar mixture of mud and straw or rice husks. The heat intake is approximately cylindrical, about 24 long and 8 inches in diameter. Cob – a mixture of mud and straw – was applied to build up and shape the outer surface of the kiln and to provide additional insulation. The entire kiln was plastered with a sand-rich mix of mud, omitting organic material that would burn during use in the interior plaster.

The lid is about eight inches thick and made of cob reinforced with wood, steel rebar, and medium-gauge wire mesh. Cob was first applied beneath the frame. With the frame in place, cob was applied to the frame interior. Then the upper layer of wire mesh was nailed into place and cob applied over the top. We made efforts to commingle the layers of cob with each other as much as possible. Nails sticking out of the wood frame provided additional surfaces for cob attachment. A layer of sand-rich earth plaster completes the lid. Holes were drilled in the four handles

protruding from the cob for connection to a rope and pulley system. Owing to its weight, we installed a block-and-tackle mechanism attached to the center support beam of the kiln building for raising and lowering the lid.

Adobe kiln construction.

Lid construction detail.

The chimney, made of tin metal and jacketed by a flowing water heat exchanger, connects to its earthen base that opens at the bottom-rear of the kiln interior. Smoke from the charcoal making process condenses in the chimney and is collected as wood vinegar, a useful natural pest deterrent. Effluent water heated by the smoke will be used to

supply a hot shower or stored for watering the nearby gardens. (A simpler chimney can be constructed using a long piece of thick bamboo; however in this instance we wanted to experiment with the condenser to gauge the degree of enhancement of wood vinegar collection, as well as make use of the source of hot water.)

The kiln is filled with wood or other organic material to be pyrolized. The lid is lowered on and sealed to the base with a sand-rich mud mixture. A fire is stoked at the heat intake for 3 – 4 hours, until the interior of the kiln becomes very hot and smoke from the chimney changes from a thin, dull gray to white and puffy. The heat intake is then sealed with adobe bricks and mud. The metal (or wood) portion of the chimney is removed and the top of the earthen portion of the chimney also sealed with mud. After the interior has cooled (2 – 3 days) the lid is lifted and the charcoal removed.

We estimate that this kiln design can provide up to 50 kilograms (110 lbs) of charcoal per batch.

For more information on pesticides and drinking water filtration using charcoal, see our website: ***aqsolutions.org***

References

[i] US EPA. National primary drinking water regulations; final rule. Federal Register, 30 January 1991. 1991; 56 20: 3526 3597.

[ii] World Health Organization website: (http://www.who.int/water_sanitation_health/dwq/wsh0207/en/index6.html) section 2.3 Charcoal and activated carbon adsorption

[iii] Pontius F. An update of the federal drinking water regs. J AWWA 1995; 87: 48-58.

[iv] Pesticide Adsorption by Granular Activated Carbon Adsorbers. 1. Effect of Natural Organic Matter Preloading on Removal Rates and Model Simplification. Matsui Y, Knappe DRU, Takagi R. Environ. Sci. Technol. 2002, 36, 3426-3431.

[v] pH-Dependence of Pesticide Adsorption by Wheat-Residue-Derived Black Carbon. Yang Y, Chun Y, Sheng G, and Huang M. Langmuir 2004, 20, 6736-6741.