wood kiln firing techniques & tips

inspiration and information for making a wood-fired kiln and firing with wood
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Inspiration and Information for Making a Wood-fired Kiln and Firing with Wood

Wood firing is the oldest firing method. Since the dawn of time when man first began to understand how fire hardened clay, wood was used almost exclusively for thousands of years out of necessity since it was the most available and easily gathered fuel. Now with so many fuel options available to the potter, wood is a choice. While wood firing isn’t easy, the results are incomparable. The work in a wood fired kiln reveals the story of the firing with pieces showing ash deposits and flame travel. But while the results can be stunning, one of the most engaging aspects of wood firing is the process itself. From the gathering and drying of wood to the hours of stoking and the tending of the fire and intense heat, there’s no other experience quite like it in ceramics.

Wood Firing Basics
by W. Lowell Baker

Each wood kiln has its own characteristics for firing, but there are some basic principles that hold true for any kiln using wood as a fuel. Here are the basics about getting the flame and atmosphere right along with the amount of air you need.

The Manabigama
by John Theis

A cross between an anagama and a groundhog-style kiln, the manabigama is a kiln that’s within everyone’s reach. Small, compact and simple to fire, this kiln can be fired by one person in a matter of hours and not days.

Wood-fired Raku Kiln
by Nesrin During

Wood firing isn’t just about high firing. You can build a simple raku kiln and fire your work with wood to get stunning results. Nesrin During constructs a simple kiln that’s easy to stoke and attain raku temperatures without a lot of effort.

High School Anagama
by Clay Cunningham

Can you imagine building a wood fire kiln at a high school? Clay Cunningham could and he did it. He tells his inspirational story of bringing together students, teachers, the community and the administration to build and fire a high fire kiln.
Wood Firing Basics
by W. Lowell Baker

Each wood kiln has its own characteristics for firing, but there are some basic principles that hold true for any kiln using wood as a fuel.

Wood burns in two distinctly different stages. The first, and most obvious, is the burning of gasses produced when wood is heated. Wood begins to gasify at about 500°F. The second is the burning of the charcoal. This happens, for the most part, after the materials that form the gasses have been driven out of the wood. The coals in your ash pit serve to provide some heat to the kiln and to gasify the freshly stoked wood, mostly through radiant heat energy. As the gasses burn in a wood kiln, they typically produce very long flames. These flames can be easily over 30 feet long. Charcoal produces very hot, but very short, flames. The flame from charcoal is normally less than a few inches long. All of these issues are relevant to building and firing any wood-burning kiln.

One of the demonstrations I take my students through when we begin talking about kiln design is to bring an oxygen-acetylene torch into the classroom. If the torch is ignited with only acetylene (fuel), it produces a very long, very dirty flame. One can quickly pass his or her hand through this flame without any real danger, but it will be covered with black soot. As oxygen is added, the flame shortens and becomes significantly hotter. As the flame shortens with the changing oxygen-fuel ratio, smaller flame tips appear in the center of the flame. This is the place where the flame is the hottest. The more defined the tips are, the hotter the flame. You want this part of the flame in the firing chamber of a kiln, not in the firebox or the flue.

If you have a small kiln and a fuel that develops a long flame, you need to either redesign your kiln to use the length of the flame, or simply shorten the flame to bring the hottest part of the fire back into the chamber where the pots are stacked. As with the acetylene example, the easiest way to shorten the flame and make it hotter is to add oxygen.

If you have electricity at the kiln site, adding a blower is one of the easiest and most controllable ways of adding oxygen.

A small squirrel-cage fan that will deliver about 100 cubic feet of air per minute will supply all the air you will need to fire a small kiln. You can fabricate a bolt-on connector to attach the pipe to the blower, or duct tape a piece of automotive tail pipe to the blower. You should realize that the end of the metal pipe will be subjected to a great deal of heat and will have to be replaced after a number of firings. Place the pipe in the ash pit of your firebox and adjust the air-input damper to the desired air flow. You will find that the flame around the blow pipe will be very intense. This system will allow you to fire your kiln with a much smaller firebox than would normally be needed in a natural-draft kiln. The smaller firebox will require more frequent stoking, simply because it will not hold as much fuel as a larger box.

Increasing the flue height would be the last choice in a small kiln. If you do this, you must be certain that you have air intake ports and a flue cross section large enough to allow easy circulation of hot gasses. A damper will be essential for control. This will be less responsive than a forced-air system and will vary more due to atmospheric conditions, because it depends on lowered pressure to bring air into the kiln.

So, more air shortens the flame and more air increases the temperature of the coal bed to help gasify your fuel more quickly.

W. Lowell Baker is currently Professor of Art at the University of Alabama, and has taught workshops for nearly 40 years.
The Manabigama

by John Theis

24 cubic feet of space, half a cord of wood, one human being
For more than thirty years now, I have been building, firing and maintaining various large wood kilns. Almost all of them have been a design taken directly from the chamber kilns used historically around the world. My present kiln is fired seven times a year for my personal work and also for group workshops. The kiln is a 300-cubic-foot crossdraft, with three chambers in the traditional noborigama style. Two of the chambers are used for glazework and one is used for salt glazing.

I started using this kiln nine years ago for teaching group workshop firings. I schedule three a year, which is all I can manage given the labor and time involved. Each year, the groups enjoy the experience and the work that comes from it, but many ask for additional space in my kiln at other times during the year, which is not possible given my production schedule.

With new ideas in mind, I set out to build a very versatile and efficient wood-firing kiln that could be used by students who had interest in a complete hands-on experience, from the preparation, loading, firing and unloading to the final clean-up phase. I didn’t want to interfere with the successful larger firings, in which students can get a large volume of wood-fired pots without the in-depth hands-on experience. The new kiln would allow me to cut down on the extensive labor, fuel and overhead costs of my larger kiln.

I named the new kiln “Manabigama” at the suggestion of my friend Phil Berneburg, former technical editor for CM. In Japanese, mana means educational or learning, bi means a thing of beauty, and gama means kiln. The Manabigama is a traditional design with a few simple modifications. I see it as a cross between an ana-gama and a groundhog-style kiln. Basically, it is a crossdraft tube built into the side of a hill.

The overall interior dimensions are 24 inches in width, 7 feet in depth, 40 inches in height. Its firebox is in the front, incorporated into the inside with a grate system, and extra air intakes are built into the front and sides. This is done to provide more secondary air intake to help burn green or wet fuel. The firebox is plenty adequate being 2 feet wide, 2 feet deep and 30 inches high from the floor to ware level. The chimney has inside dimensions of 9 inches deep by 18 inches wide and is 12 feet high. The shape is a long rectangle with two straight, 18-inch-tall side walls and a catenary arch built on top. This creates ample headroom for ease of loading, as well as extra height for stacking and tall pieces.

There is approximately 24 cubic feet of ware space, more than enough for teaching purposes. The kiln door is in front, only halfway down, and is bricked up including the stoke hole. It can be loaded in two to three hours, fires evenly to Cone 10–12 in eight hours tops, or if you choose, you can fire two to three days depending on how much ash buildup you like. The consumption of fuel is also minimal—less than half a cord of wood.

All in all, the Manabigama is a very simple design to build. It is capable of yielding wonderful ash-glazed pieces with a minimum of labor, fuel and overhead costs. And it is a fantastic wood-fired kiln for teaching without the tremendous strain of a large three-chambered kiln.

Thanks to Phil Berneburg, who was instrumental in inspiring me to build this kiln. For further information on Monocacy Pottery, see www.monocacypottery.com.
I had attended kiln workshops for several years, and felt I was ready for more. I was looking for a wood kiln that I could try to fire by myself when John called and said, “Come see my new kiln. I think you’re going to like it.” Of course I volunteered to test fire it.

I had help and John was always nearby, but for the first time I was able to manage the entire process, which was my goal for this firing. The kiln’s design is just right for a student at my level. All of its processes are small, straightforward and flexible. I love that there is no barrier between the firebox and the pots, so the pots receive as much effect from the fire as possible. This is my goal aesthetically too.

I am already busy designing pots for my next kiln load. I plan to gain as much understanding as I can each time I fire it, and enjoy every minute of it. This kiln is going to carry me to a point in the future when I’m ready to build my own. And when I get there, I’ll probably build something very similar.

Bottle, 5 in. (13 cm) in height, stoneware with natural fly ash glaze, wood fired to Cone 12 in the Manabigama, by Mea Rhee, Silver Spring, Maryland.
Wood-firing Raku Kiln
by Nesrin During

Texel is a small Dutch island on the North Sea. It is an island of sand dunes, natural lakes, sheep, tourists, wind and rain. In these quiet surroundings, I have been making ceramics for over 20 years. Some of my work is wood fired in a simple, self-built raku kiln. It is simple because it is actually made of stacked bricks and sized to fit what I’m planning to fire (sometimes I start firing small objects, then aggrandize the kiln by adding another one or two rows of bricks for the bigger objects).

These kilns are built wherever I want them to stand, taking into consideration the direction of the wind. The day after I’ve finished firing, I put away the bricks, out of sight under a roof or in a shed to keep them dry until the next firing.

Wood firing isn’t just for the high firing. You can build a simple raku kiln and fire your work with wood to get stunning results.

Handbuilt vessel, approximately 6 inches in height, with iron-spotted raku glaze, reduced in sawdust, by Nesrin During.

Wood-fired raku vessel, approximately 6 inches in height, handbuilt, with poured glazes.
Kiln Construction

A typical kiln is built from about 50 insulating bricks (IFBs), a square kiln shelf (size depending on what I want to fire), a metal grill for a grate, a piece of sheet metal, and some broken shelf pieces. It takes about 45 minutes to build, and fires to about 1650°F in about 45 to 60 minutes for the first firing; thereafter, every load takes 15 to 20 minutes (one can see the glaze melting, the pots shining in the flames, from the top of the kiln).

To begin, I level the surface with a layer of dirt; it will also protect what is beneath (concrete, for example, can crack with the heat). I look at the direction of the wind and accordingly build the firemouth to receive the wind.

Depending on the size of the kiln shelf (it’s going to diagonally span the walls), I lay two courses of bricks to establish the back and side walls. Upon these the grate is placed so that the ashes can fall through (figure 1). (My iron grate was salvaged from a dump; one could also use a kitchen stove grate, which would last a few firings). Then another two rows of bricks are laid, and the kiln shelf placed diagonally so that the walls support three corners. A piece of sheet iron (also salvaged from the dump, but you can also use a piece of angle-iron) across the front of the kiln supports the fourth corner (figure 2).

Because some of the bricks in the following course is placed so that the ashes can fall through (figure 1). (My iron grate was salvaged from a dump; one could also use a kitchen stove grate, which would last a few firings). Then another two rows of bricks are laid, and the kiln shelf placed diagonally so that the walls support three corners. A piece of sheet iron (also salvaged from the dump, but you can also use a piece of angle-iron) across the front of the kiln supports the fourth corner (figure 2).

Because some of the bricks in the following course stands on the kiln shelf, so level with pieces of broken kiln shelf. After another course of bricks, a sheet of iron across the firemouth supports the corner of a kiln shelf. The kiln fires to about 1650°F in 45 to 60 minutes, while pieces for the next firing preheat on top.

Two courses of bricks are laid to establish the back and side walls, then an iron grate positioned on top.
Firing

I fire this kiln (alone or with the help of students) with scrap wood. Make sure the wood should be dry and thinly split. I start with some newspaper and thinly split wood (figure 4).

The fire is well fed in the beginning in order to get the bricks to temperature, but after the first load is done, I fire with less wood and rake the fallen ash from underneath the grate to ensure the fire has enough oxygen to burn well.

Because the kiln is so loosely stacked, I can easily create new openings in between bricks to manipulate the flames toward a certain direction, causing interesting effects on pots.

The pots intended to go into the next firing are placed on top of the kiln to dry. When the glaze on the pots inside the kiln is shiny and molten, I remove a few bricks from one side of the top to facilitate taking the pots out (figure 5); the pots are then placed in a metal bin containing sawdust (figure 6).

The glaze is a simple: alkali-borate frit (70%) with kaolin (30%). With additions of 0.5% to 3% iron oxide, this gives very beautiful pinks and grays (pink to pomegranate red in oxidation, and gray to black in reduction). Additions of 2% to 3% copper carbonate yield apple green in oxidation and bordeaux red in reduction. Other oxide combinations, such as iron and copper, or iron and manganese, are also good.

The amount of crackle depends on the type of clay used and the handling. After taking the piece out of the kiln, if you keep it in the air for a minute or so before putting it in the reduction container, you’re bound to get more crazing, especially on a smooth surface. If the surface is rough, you’re more likely to get iron oxide “bleeding,” producing thousands of little dots and giving the piece a rocklike appearance.

Building such a kiln requires few materials, and fuel for firing is equally economical. Because it is a wood firing, there is bound to be some oxidation and some reduction at the same time. The resulting variation in surfaces gives beauty and individuality to the work. Not every piece comes out well, but some are really wonderful.
High School Anagama
by Clay Cunningham

Wood firing is making its way into the schools, and Clay Cunningham describes how he built and fired a wood with community and student support.

Many eyebrows were raised when I first began planning the construction of an anagama wood kiln at Lewis Central High School in Council Bluffs, Iowa, where I teach. Other potters said that it just wasn’t done at the high school level while administration voiced concerns over several issues. But the students expressed surprise for the most obvious reason—excitement! Despite my own enthusiasm, we spent a year planning the project not only to increase safety, but to ensure the project’s success and longevity.

Workshop Format
Since this is a high school, the students and faculty need to be in classes six straight hours a day, everyday. To avoid conflicts, I decided to direct the project in the form of a summer workshop in June. With a healthy mix of eight adult potters from the community and ten students from the high school, we had plenty of able hands, as well as a safe and constant adult/student firing team. I planned a single-chamber kiln that would have great atmospheric potential, yet would fire over a weekend during the school year. Instructed as a three-week course, we spent the first week building the kiln, the second week making pots and sculptures, and the third week loading, firing and cooling the kiln.
Building the Kiln

We began by laying out a 15-inch high foundation of concrete blocks, on which we placed 9 inches of K23 hard brick in an alternating header and stretcher fashion to create a total interior floor plan that measured 45×96 inches (figure 1). The first three feet of the interior was reserved for the firebox with the remaining five feet, tiered up 6 inches, for the ceramic ware. The flooring in the firebox area was constructed with K26 hard brick to better withstand the cone 10 temperatures we would be reaching. Similarly, the walls were constructed 9 inches thick by alternating courses of stretchers and headers to a height of 15 inches.

Before adding the arch, we lined the outer walls of the kiln with cinder blocks to a height of 37 inches, then filled the blocks with rebar and mortar mix. The small 4-inch gap between the concrete blocks and the hard brick was then filled with pea gravel to support the force of the dome on the kiln wall and to increase insulation and to allow for thermal expansion (figure 2). The exit flue to the chimney was created slightly oversized at a total of 22½×22½ inches with the chimney interior at 13½×13½ inches. The chimney was built with hard brick to a height of 15 feet and finished with a 4-foot stack anchored with cables into the ground on three sides. A removable spanner brick was placed above the damper to act as a passive damper.

The Roof

Instead of making a wooden frame for the arched roof, we used excess dirt from the construction site of a nearby middle school to make a solid mound inside the kiln. With a couple shovels and a lot of muscle we piled on two truckloads of dirt to form a smooth curved dome. Once shaped to our liking, we then mixed high refractory castable to form the dome. Since we were on a budget, we mixed all 2400 pounds of castable by hand with a hoe and mortar tray to a consistency of thick concrete.

Next, we lined the dirt with plastic bags and added one ball right on top of the other until the entire dome was completed to a thickness of 9 inches (figure 3). Using two plastic buckets, we added the balls around the buckets so that when the buckets were removed, we had negative spaces for side stoking (figure 4). After the last ball, we covered the entire dome with plastic bags to let it cure overnight. The next day we lined the dome with fiber blanket and an adobe mix of mortar, dirt and straw. This not only further insulated the kiln, but also protected the castable from the snow and rain.

**Caution:** As a safety precaution, everyone wore face masks and rubber gloves while handling the fiber blanket, as the small particles can irritate the lungs and the skin. Rubber gloves are recommended when handling adobe as we. Concrete can irritate skin (and it makes your fingers pruney). After the castable set up, the door was disassembled and the dirt was removed. At last, after five days, the Lewis Central Anagama was complete.

A concrete block wall helps bear some of the weight of the roof and is placed 4 inches from the sides. The gap is later filled with pea gravel.
Making Work

The next week was spent making a wide variety of pottery for the kiln. I provided three different clays to use with maturing rates from cone 6 to cone 10. In addition, a variety of tried-and-true high-fire glazes were supplied from copper reds to celadons and shinos. Students were encouraged to keep good notes of which clays and glazes were used for each piece to reflect on successes and learning experiences.

Getting Ready

Over the weekend, we spent one full day loading the pieces into the kiln. Tumble stacked one on top of the other, nearly every nook and cranny of the kiln was used. By Sunday, the front of the kiln was bricked up, leaving a main stoke hole and primary air inlets at the bottom of the door. Using a homemade block of castable, an eyebolt and some chain, we were able to suspend a movable door from a post and lintel so that wood could be stoked with minimal heat loss.

Firing

The kiln was started with a small fire at 5 PM on Sunday. By early Monday morning the kiln was nearing 1800°F. Working in teams of two or three and stoking several split logs at the end of every reduction cycle, the kiln climbed to 2200°F by Monday evening. We were at cone 10 by noon on Tuesday (figure 5) and held it at that temperature until 5 PM when we stopped stoking and sealed the kiln. To help ensure a slow cooling, we dipped newspapers into a large barrel of slip and completely coated the entire kiln with the dripping wet sheets to decrease heat loss. This, as you can imagine, was a fun and messy highlight of the entire experience.
The Results

After three days of cooling, it was time to open the kiln. The old adage of a unloading a kiln unloading feeling like Christmas morning could not be more apropos (figure 6). All of the students, young and old, came early to see their approximately 400 newly finished creations and enjoy a potluck meal with a new family of bonded potters. We had much to celebrate. We were able to load and fire the kiln in the course of a weekend with just under two cords of wood. We proved that an anagama is not only doable at the high school level, but an amazing learning tool that will provide students with a life-long experience. We will be firing it up again this summer and our pottery club is in full swing to fill the quota.

Clay Cunningham is a ceramic artist and instructor, currently teaching at Lewis Central High School in Council Bluffs, Iowa. To see more of his work, or for contact information, visit www.claycunningham.org.