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electric kiln firing techniques & tips




inspiration, instruction and glaze recipes for electric ceramic kilns

Electric Kiln Firing Techniques and Tips

Inspiration, Instruction and Glaze Recipes for Electric Ceramic Kilns

Electric kiln firing is one of the most common firing methods because electric kilns are readily available and simple to install, but that doesn't mean that electric firing yields common results. Electric kilns can be incredible tools in the pottery studio. In this collection of articles, you will see how creative potters and ceramic artists are using electric kilns to create exquisite ceramic art.

Not only can electric kilns produce great results, but they also offer control and dependability. And electric kilns keep becoming more versatile, economical and easy to use with advances in controllers, energy efficiency, materials and safety. Here, you'll learn ways to improve your electric firing results and be ready to take advantage of the incredible potential electric kilns have to offer.

Electric Kiln Success

by Jonathan Kaplan

Jonathan Kaplan explains how layering and combining cone 6 glazes and using a controlled cooling cycle can create some exciting surfaces in a electric firing.

Satori Yamaoka's Electric and Propane Combination Firing

by Bob McWilliams

Learn how Satori Yamaoka combines both oxidation and slight reduction to create amazing oil-spot surfaces in his innovative electric and propane kiln. Plus he shares his kiln diagrams and glaze recipes.

Wood Ash Glazing in an Electric Kiln

By Harry Spring

Potter Harry Spring shares his cone 6 wood-ash glaze recipes and explains how has come to appreciate the convenience of electronically controlled kilns.

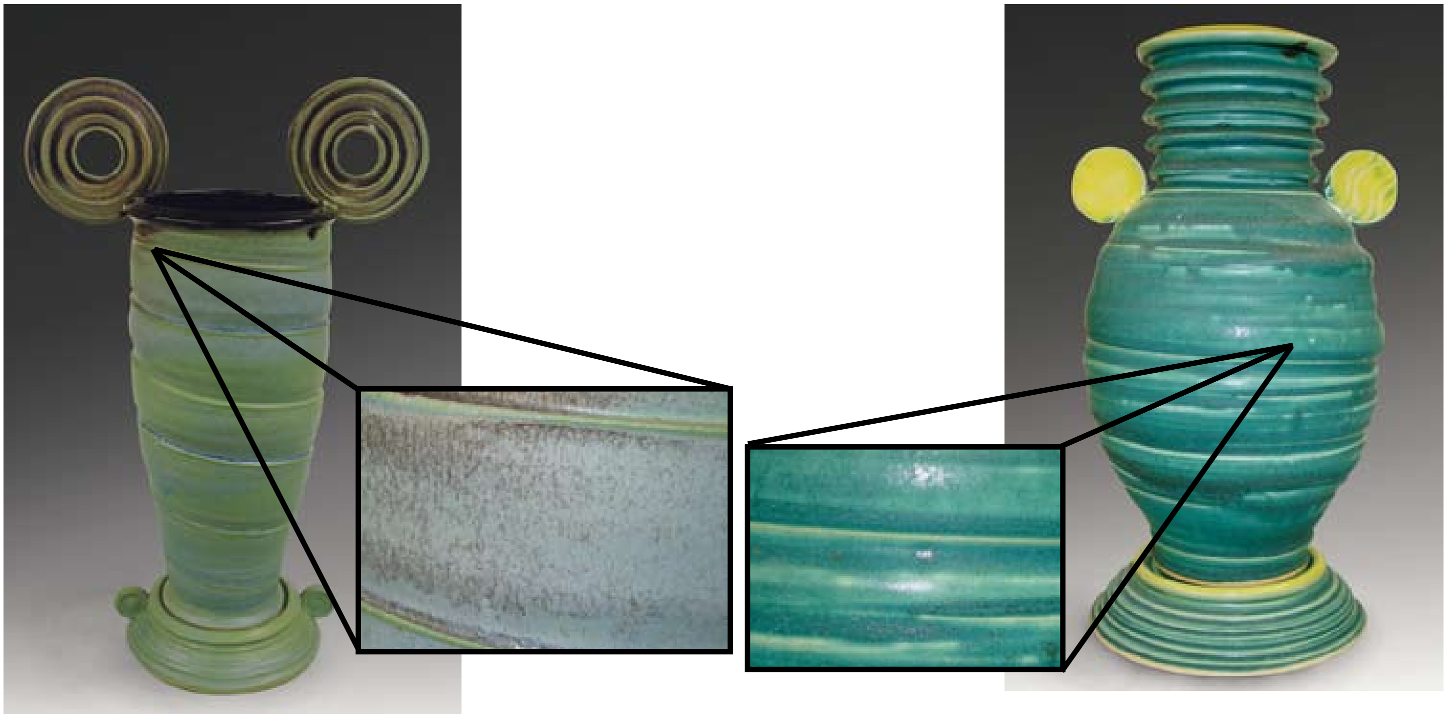
Ten Basics of Firing Electric Kilns

From the Pottery Making Illustrated Instructor's File Archives

If you missed the lecture on firing electric kilns, you'll appreciate this refresher course that covers all the bases.

Electric Kiln Success

by Jonathan Kaplan



Left: "Disk Vase," 18 inches in height, with Blue/Green/Purple variation of VC Glaze with PV Black sprayed over. The detail shows the cooling crystals that developed during a controlled slow cooling. Right: "Vase with Circular Attributes and Stand" 15 inches in height, with Edgy Green glaze. This glaze contains barium, which helps in the formation of small suspended crystals giving it a satin matt finish.

Color and texture in cone 6 glazes are the result of three variables: First, selecting proper glazes; second, learning how to layer and combine different glazes by pouring, dipping and spraying; and third, using a controlled cooling cycle to further enhance the color and texture.

This slow cooling not only creates a visual dialog in thick and thin areas of glaze application, but also helps with the crystallization of certain materials, which adds depth and interest to the glaze.

Glaze Selection

With so many cone 6 glazes, how do you know which glazes will work for you? It's impossible to look at a written glaze formula and know how it will look when it's fired and cooled. However, there are some things to look for that may provide some insight as to the surface texture. I like to use glazes that have a strong presence of calcium, provided by whiting and wollastonite in the formula. Dolomite, which is a combination in equal parts of both calcium and magnesium is also very helpful. These materials, when included in any glaze along with other ceramic materials, form small, suspended crystals in the glaze when cooled in a controlled manner.

Glaze Application

I spray or dip glazes over each other. My experience is that no single glaze can provide a visually interesting surface in an electric kiln, although there may certainly be exceptions. My layering technique allows the many differing glaze materials to combine and melt in unique ways providing a visually interesting surface with depth. All of this is caused by the interactions of multiple materials applied over each other. Applying glazes over textures in the clay allows the melted glaze to pool. A thicker concentration of glaze materials in these areas yields different areas of color.

When mixing and testing glazes for future use on your pottery, it is useful to try different methods of combining glazes. For example, if you mix up a few small test batches of different glazes, try dipping one glaze over the other on the top rim of your test tile. Then reverse the order. For instance, if you dip glaze A over glaze B, then do another tile with glaze B dipped over glaze A.

Firing

Most glazes have a range of several cones. I fire my cone 6 glazes to cone 7 using a programmable controller with the following heating and cooling cycle:

1st segment	50°F/hour to 220°F
2nd segment	250°F/hour to 2167°F
3rd segment	150°F/hour to 1500°F

I have found that this provides a better melt and allows a good mingling of the many layers of glaze. It's necessary to experiment and test your glazes to determine their range. Kiln wash or stilts under your ware is a necessity!

It is fine to program a "hold" into the end of the second segment if you have a single zone kiln and wish to try to even out the firing from top to bottom. With the introduction of multiple zone controls on many of the new kilns, a soak at the end is not really necessary. If you don't have a computer-controlled kiln, use the infinite switches to "fire down" the kiln. With the addition of a pyrometer and a decent thermocouple, you can achieve a reasonable controlled cooling cycle.

Record Keeping

It's important to keep accurate records so when you get results that are pleasing, you can repeat them. In an electric kiln, repeatable results are easier to achieve than in a fuel-burning kiln, especially if your electric kiln is equipped with a programmable controller. There is no substitute for experimenting. It takes time and persistence to achieve the surfaces that are pleasing to you. No one glaze or method will work. It is a combination of glazes and applications, followed by the proper firing with a controlled cooling cycle.

Jonathan Kaplan has been working in ceramics for more than 30 years as an artist, potter, ceramic designer and educator. He currently resides in Denver Colorado, and curates Plinth Gallery.

See www.jonathankaplanceramics.com and www.plinthgallery.com.

Recipes

Always test new glazes before committing them to your finished work!

PV Base
Cone 6

Gerstley Borate	30 %
Whiting	10
PV Clay	15
Custer Feldspar	35
Silica	10
	100 %

Black liner glaze:
Add: Mason 6600 . . . 6 %

An excellent gloss base. Spray or dip over Blue/Green/Purple. This glaze is very receptive to commercial stains. Again, with encapsulated stains, an opacifier is not necessary. If a more opaque surface is desired, add between 6–10% opacifier such as Zircopax.

VC Glaze
Cone 6

Whiting	6.9 %
Gerstley Borate	11.6
Titanium Dioxide	6.9
Nepheline Syenite	46.8
Kaolin	13.9
Silica	13.9
	100.0 %

"Blue/Green/Purple" variation
Add: Cobalt Oxide . . . 1.1 %

An excellent base glaze to spray or dip other glazes on top.

Edgy Green
Cone 6

Barium Carbonate	15.6 %
Gerstley Borate	10.4
Wollastonite	15.6
Nepheline Syenite	39.7
Kaolin	10.4
Silica	8.3
	100.0 %

Add: Black Copper Oxide . . . 3.1 %

Satori Yamaoka's

Electric and Propane Combination Firing

by Bob McWilliams

"Iraho Vase," 28 centimeters (11 inches) in height, wheel-thrown local clay, with Iraho Glaze, fired to Cone 9 in reduction, ¥40,000 (US$388), 2003.

"Ryokusai Kujaku Bowl," 29 centimeters (11 inches) in diameter, wheel-thrown local clay, with Peacock Glaze, fired to Cone 9 in reduction, ¥23,000 (US$223), 2003.

I arrived in Tokyo, along with 200 other K–12 teachers in all disciplines from across the United States, for a three-week teaching fellowship program. For one of the three weeks, a small group of us went to Iwamizawa, Hokkaido, (the second largest and northernmost of Japan's four main islands) to learn about schools and people in the area. Naturally, being a studio potter/teacher, I was interested in the potters of Hokkaido. Before leaving Hawai'i, where I teach high-school ceramics, I heard about a potter in Iwamizawa named Satori Yamaoka.

Yamaoka's studio is one of the most organized and clean shops I have ever seen. As he came out to greet us, he motioned for us to come upstairs from the showroom to a much more exhibition-oriented gallery where, behind glass cases, were some of the most treasured pieces of Yamaoka, his father and his son. There were beautiful reds and purples on bowls and platters, oil-spot Temmokus, vases with excellent stain or enamel brushwork, marbled incense pieces, teabowls, and other chanoyu (Japanese tea ceremony) objects.

Originally a glaze technician with Noritake in Nagoya, Yamaoka's father Miaki Yamaoka followed his mentor to Hokkaido in 1926 and set up his own pottery shop called Kobushigama (kobushi means tree; and gama means kiln) in Iwamizawa in 1946.

Satori Yamaoka was born in 1938 in Sapporo and studied pottery in Kyoto at the Kyomizuyaki art school. He started working with his father and two other potters in the Iwamizawa studio in 1959.

Miaki was a big influence on his son in many ways. Satori, like his father, has a passion for testing glazes and clay bodies. His clay bodies are always changing. There are not many raw materials in Hokkaido (although there is an abundance of clay) so he brings in a lot of raw materials from Nagoya and Mie. In a large attic area, piles of raw materials dry on tarps. The Kobushigama studio uses almost 20 tons of clay each year.

Glazes also are a joy and technical challenge for Yamaoka. He is always testing formulations on small bisqued buttons. His upstairs glaze-calculation area holds sets upon sets of small powders on papers with recipes written on them. Large and small ball mills were grinding away. Finished glaze tests were everywhere.

Yamaoka also makes a lot of his own ash glazes, burning and cleaning and adding other materials. He especially likes apple and straw ash. He keeps many boxes of different ash, all waiting their turn for testing. This penchant for continual glaze and clay body testing also has caught the interest of Yamaoka's son, who has been working at Kobushigama since 1993.

Satori and his father had many kilns over the years. His father started firing with coal and then switched to electric. For a while in 1966, they fired in a big, oil-fired kiln. Satori now uses four kilns. One is a 30-cubic-foot softbrick downdraft car kiln fired with propane, which he fires about once a month. Mostly firing for copper reds in this kiln, he spreads the firing out over about 17 hours and gets some beautiful results. Since the cost of propane is so high in Japan, he has fired with electricity for quite some time.

An incredible amount of ware runs through this shop. I was impressed by the fact that there were only three wheels in the throwing area, and ware was everywhere! Kobushigama forms are not radical, but they are exquisitely thrown, trimmed and glazed. Approximately 80% of production is ordered directly from Yamaoka or sells through the showroom. Most of his sales outside of the showroom are through shops in Sapporo. Total sales of Kobushigama amount to about $330,000 each year—an amazing amount of production! Yamaoka's is truly a story of a modern and successful, yet classic, approach to pottery in Japan today.

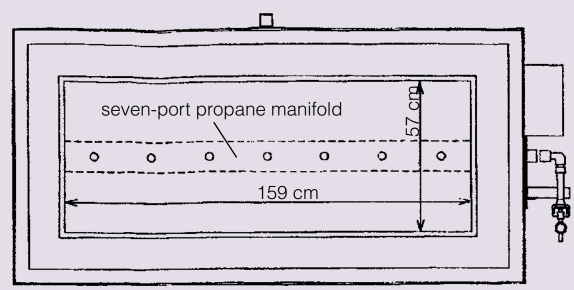
A Propane and Electric Kiln

One of the more interesting aspects of Yamaoka's firing method involves combining electric and propane, a method he has used for about 40 years. He has three electric kilns that go to Cone 9, all of which are designed to allow a small amount of propane to be used at a certain point during the firing cycle.

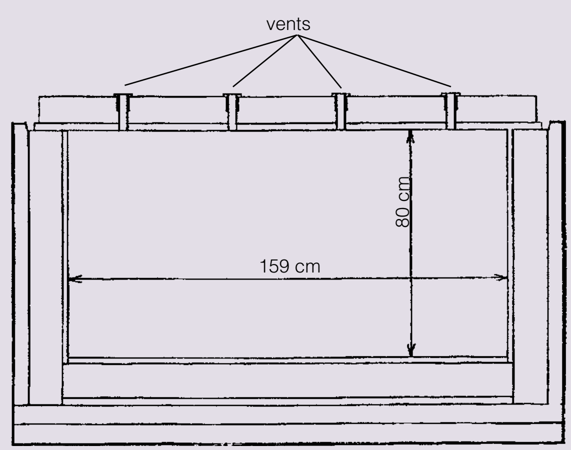
Using a computer that he has programmed to increase the rate of heat evenly with straight oxidation, electricity is used as the only heat source in the beginning of the firing. At around Cone 08, he introduces a small amount of propane to slightly reduce the atmosphere. This continues to Cone 9, which usually takes 24 hours.

This type of firing has evolved from considerations of cost and the colors Yamaoka wants in the finished ware. The kilns are large, custom-made, rectangular, top-loading electric kilns. The interior dimensions are 159×57×80 centimeters (63×22×32 inches), with about 23 centimeters (9 inches) of brick and fiber insulation. Electric elements are anchored to the fiber hot-face. There are eight exit ports about 3 centimeters (1¼ inches) in diameter on the sides, front and back (two on each side). A ratchet-and-cable system lifts and holds the lid open.

Yamaoka fires about 10 electric/propane firings per month. The exact firing schedule varies a lot, but the first part is always electric guided by computer. There are always variables that affect the latter part of the schedule: stacking, which glazes are included, whether saggars are used, etc. So when the propane is introduced, things may change from firing to firing.



Top cutaway view of rectangular electric/propane kiln. The manifold that delivers propane to the kiln extends across the length of the center of the kiln floor, with ports every 20 centimeters (8 inches).



Front cutaway view of rectangular electric/propane kiln. Four lid vents draw the propane through the kiln, ensuring even reduction throughout the stack of ware.

recipes

Namako Glaze, 1st Layer

(Cone 9)

Magnesium Carbonate	4 %
Strontium Carbonate	3
Whiting	10
Potash Feldspar	50
Kaolin	11
Silica (Flint)	22
	100 %
Add: Cobalt Carbonate	1 %
Red Iron Oxide	8 %

Namako Glaze, 2nd Layer

(Cone 9)

Barium Carbonate	4.5 %
Bone Ash	4.5
Magnesium Carbonate	13.0
Talc (Mitsuishi Soapstone)	13.0
Whiting	7.0
Potash Feldspar	40.0
Silica (Flint)	18.0
	100.0 %
Add: Zinc Oxide	2.5 %

Namako Glaze, 3rd Layer

(Cone 9)

Synthetic Ash	45 %
Potash feldspar	45
Kaolin	10
	100 %

Mixed Clay Ash (Synthetic Ash)

Magnesium Carbonate	6 %
Phosphorus Pentoxide	6
Whiting	63
Potash Feldspar	12
Kaolin	10
Silica (Flint)	3
	100 %

Iraho Oxidation Glaze

(Cone 9)

Ofuyu Stone*	60 %
Azuma Ash Clay**	32
Silica (Flint)	8
	100 %

Iraho Reduction Glaze

(Cone 9, reduction)

Ofuyu Stone*	65 %
Whiting	30
Potash Feldspar	5
	100 %

Oil-Spot Temmoku 1

(Cone 9)

Ofuyu Stone*	40.9 %
Potash Feldspar	31.8
Kaolin	18.2
Silica (Flint)	9.1
	100.0 %

Oil-Spot Temmoku 2

(Cone 9)

Ofuyu Stone*	50.0 %
Potash Feldspar	8.3
Kaolin	33.4
Silica (Flint)	8.3
	100.0 %

Oxidation Ash Glaze 1

(Cone 9)

Synthetic Ash	45 %
Kamado Feldspar (Potash)	45
Bankei Kaolin	10
	100 %

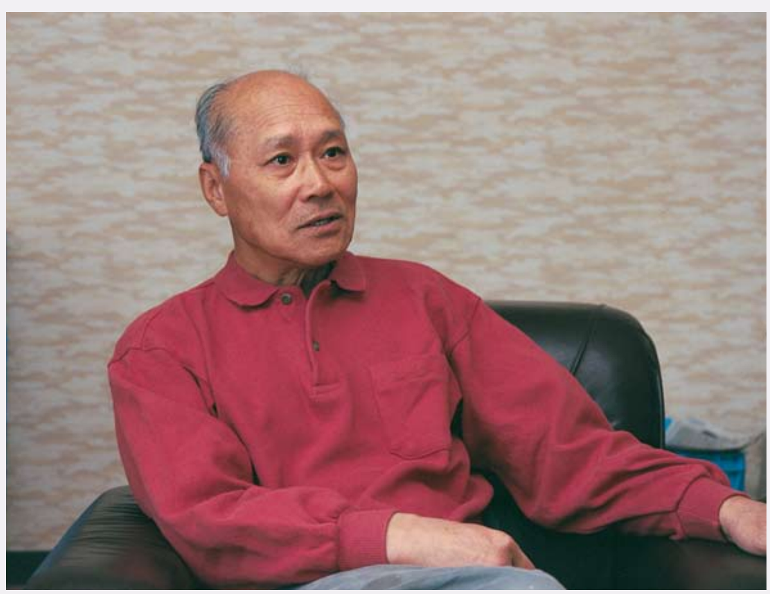
Oxidation Ash Glaze 2

(Cone 9)

Synthetic Ash	40 %
Kamado Feldspar (Potash)	50
Bankei Kaolin	10
	100 %

*Feldspathic stone containing 5% iron oxide

**Natural ash clay from burnt woods of Hokkaido



Satori Yamaoka has been producing pottery and testing glazes at his shop, Kobushigama, in Iwamizawa City, Hokkaido, Japan, for almost 60 years.

Peacock Glaze

Because this glaze involves several layers, thickness will affect the result. First, apply all three Shinsha Glazes and fire in reduction to Cone 9. Then, pour any one of the Kujaku (Peacock) Glazes, then any type of Ash Glaze #1 and Ash Glaze #2. Fire again in reduction to Cone 9.

Shinsha Glaze, Layer 1

(Cone 9, reduction)

Barium Carbonate	18 %
Whiting	7
Potash Feldspar	38
Kaolin	12
Silica (Flint)	25
	100 %
Add: Red Iron Oxide	1 %

"Kujaku Round Plate," 23 centimeters (9 inches) in diameter, wheel-thrown local clay, with Peacock Glaze, fired to Cone 9 in reduction, ¥15,000 (US$146), 2003.

Shinsha Glaze, Layer 2

(Cone 9, reduction)

Barium Carbonate	8 %
Bone Ash	2
Magnesium Carbonate	4
Strontium Carbonate	7
Whiting	7
Potash Feldspar	58
Kaolin	3
Silica (Flint)	11
	100 %
Add: Copper Oxide	1 %
Tin Oxide	3 %

Shinsha Glaze, Layer 3

(Cone 9, reduction)

Barium Carbonate	8 %
Whiting	25
Potash Feldspar	61
Kaolin	2
Silica (Flint)	4
	100 %
Add: Tin Oxide	5 %

Kujaku (Peacock) Glaze, Type 1

(Cone 9, reduction)

Barium Carbonate	11 %
Bone Ash	2
Magnesium Carbonate	3
Strontium Carbonate	6
Whiting	8
Potash Feldspar	42
Kaolin	8
Silica (Flint)	20
	100 %
Add: Copper Oxide	4 %
Tin Oxide	3 %
Silicon Carbide	4 %

Kujaku (Peacock) Glaze, Type 2

(Cone 9, reduction)

Barium Carbonate	8.0 %
Bone Ash	2.0
Magnesium Carbonate	3.0
Strontium Carbonate	4.5
Whiting	9.0
Potash Feldspar	46.0
Kaolin	4.5
Silica (Flint)	23.0
	100.0 %
Add: Copper Oxide	1.5 %
Tin Oxide	3.0 %
Silicon Carbide	1.0 %

Kujaku (Peacock) Glaze, Type 3

(Cone 9, reduction)

Barium Carbonate	10.0 %
Bone Ash	2.0
Magnesium Carbonate	2.0
Whiting	9.0
Potash feldspar	40.0
Bankei Kaolin	10.0
Kaolin	7.0
Silica (Flint)	20.0
	100.0 %
Add: Copper Oxide	1.5 %
Tin Oxide	3.0 %
Silicon Carbide	2.5 %

Ash Glaze #1, Type 1

(Cone 9, reduction)

Taihei Burnt Straw Ash	20 %
Whiting	2
Wood Ash	18
Potash Feldspar	48
Bankei Kaolin	12
	100 %

Ash Glaze #1, Type 2

(Cone 9, reduction)

Taihei Burnt Straw Ash	30 %
Whiting	2
Wood Ash	18
Potash Feldspar	40
Bankei Kaolin	10
	100 %

Ash Glaze #1, Type 3

(Cone 9, reduction)

Taihei Straw Ash	40 %
Whiting	2
Wood Ash	18
Potash Feldspar	32
Bankei Kaolin	8
	100 %

Ash Glaze #1, Type 4

(Cone 9, reduction)

Taihei Burnt Straw Ash	16 %
Whiting	6
Wood Ash	14
Potash Feldspar	42
Bankei Kaolin	18
Silica (Flint)	4
	100 %

Ash Glaze #1, Type 5

(Cone 9, reduction)

Taihei Burnt Straw Ash	16 %
Whiting	9
Wood Ash	21
Potash Feldspar	35
Bankei Kaolin	15
Silica (Flint)	4
	100 %

Ash Glaze #1, Type 6

(Cone 9, reduction)

Taihei Burnt Straw Ash	20.0 %
Whiting	12.0
Wood Ash	28.0
Potash Feldspar	24.5
Bankei Kaolin	10.5
Silica (Flint)	5.0
	100.0 %

Ash Glaze #1, Type 7

(Cone 9, reduction)

Taihei Burnt Straw Ash	24 %
Whiting	9
Wood Ash	21
Potash Feldspar	28
Bankei Kaolin	12
Silica (Flint)	6
	100 %

Ash Glaze #2, Type 1

(Cone 9, reduction)

Taihei Straw Ash	9 %
Whiting	18
Potash Feldspar	45
Shibun Soft Stone*	28
	110 %

Ash Glaze #2, Type 2

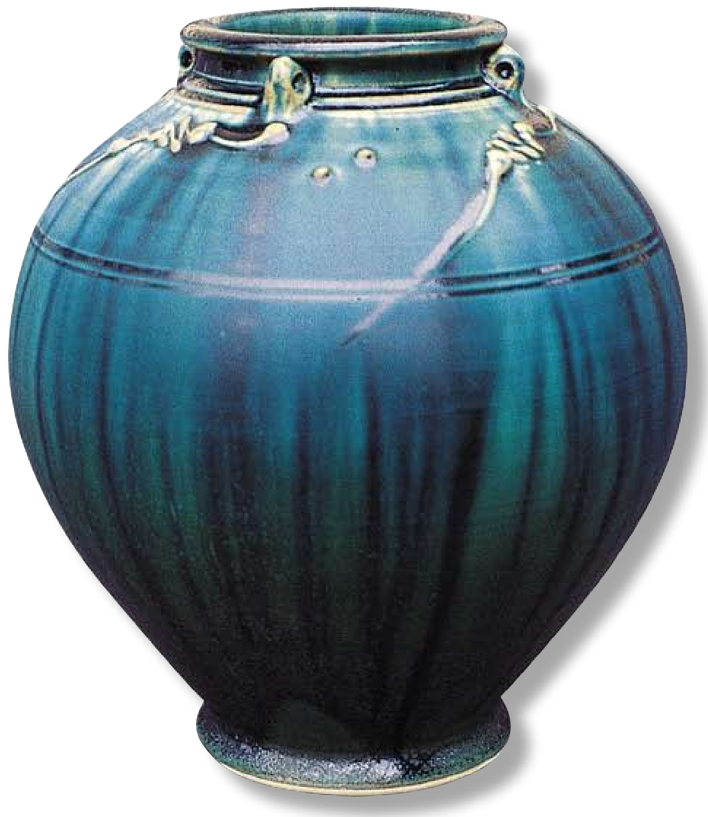
(Cone 9, reduction)

Taihei Straw Ash	9 %
Whiting	37
Potash Feldspar	27
*Shibun Soft Stone	27
	110 %

*Feldspathic rock from Iwamizawa, Hokkaido

Wood Ash Glazing in an Electric Kiln

by Harry Spring



Round vase, 9 inches in height, white stoneware, with slip trailing, blue Wood Ash Glaze over Green Dragon Matt Glaze, fired to cone 6 in oxidation.

High firing in a gas kiln for many years does have a downside. You can come to depend upon the kiln to give you the wonderful, serendipitous effects that are part of the magic of reduction. Of course, we all know that wonderful glazes can also be achieved without reducing the kiln's atmosphere. Several years ago, I was forced through circumstances to use an electric kiln as my only firing source for my line of production stoneware. Since then, I have not only come to "put up" with electric firing and the challenges of a static kiln atmosphere, but also to appreciate the convenience of electronically controlled kilns and the challenge of discovering ways of developing interesting and even exciting glaze effects.

I began by testing several commercial clays, and settled on a white stoneware (Miller 65) that was both durable and totally vitrified at cone 6. Available through Laguna Clay Company, it is good for throwing small- to medium-sized pieces, weighing 1 to 10 pounds.

I then experimented with ways to develop more interesting surfaces. I tried carving patterns into the clay to create places where the glaze could flow and pool. Another technique that I learned from a friend in California was to take the slurry from my throwing bucket, run it through a 60- to 80-mesh sieve and apply it with an ear syringe for trailed-slip patterning.

Next, I tried overlapping two and three glazes to create some movement on the surface. This worked wonderfully, but caused some irregularities where the glaze saturated the bisqueware, and some running onto the kiln shelves when the glaze application was too thick. I found I could control the application thickness more easily and avoid running by spraying the second and third coats of glaze.

Most recently, I have begun using wood ash in and over my Cone 6 glazes to create visual interest. The results have been very exciting. I was fortunate to find a recipe that does not require washing the ash before adding it to the glaze. Of course, this makes a glaze that is somewhat caustic, but I wear surgical gloves when I glaze anyway, so this has not been a problem.

I have found that this recipe works best if it is dipped or sprayed over another glaze; alone, it is a little too dry to the touch. I like using Wood Ash Glaze over a matt glaze rather than a gloss glaze.

To prepare the wood ash, screen the dry ash (any wood will do) through a 60- to 80-mesh sieve and add it to the glaze batch.

Another way to achieve interesting effects is to simply sieve wood ash over the damp, newly glazed surface. I do this over a trash barrel. (Remember: ash is caustic, so always wear a mask.)

For the most dramatic effects, do both. Sieve the dry wood ash over the rim and shoulder of a pot that has just been sprayed with Wood Ash Glaze over a dipped or sprayed base glaze, such as Green Dragon Matt Glaze.

Wood ash contains a good deal of calcium, as well as potassium, phosphorus, magnesium and sodium—all rather active fluxes in a glaze—so I limit the application of Wood Ash Glaze to the top fourth of the pot.

Green Dragon Matt Glaze

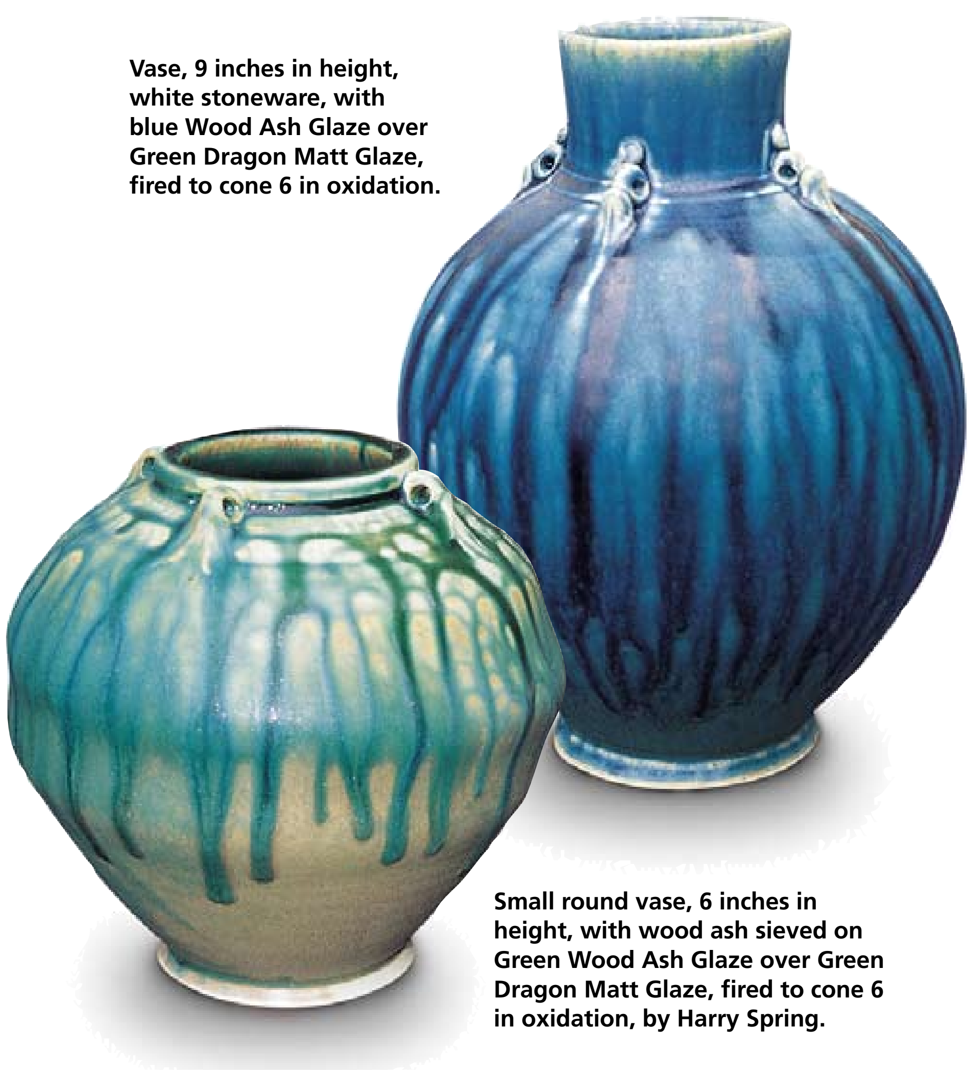
(Cone 6)

Whiting	17.7 %
Zinc Oxide	8.0
Cornwall Stone	22.0
Soda Feldspar	44.1
Bentonite	3.2
EPK Kaolin	5.0
	100.0 %
Add: Titanium Dioxide	4.0 %
Copper Carbonate	4.3 %

Frasca Wood Ash Glaze

(Cone 6)

Whiting	11.4 %
Wood Ash (unwashed)	54.6
Potash Feldspar	11.3
Ball Clay	11.3
Silica	11.4
	100.0 %
Green	
Add:Copper Carbonate	4.0 %
Blue	
Add: Cobalt Carbonate	2.0 %



Vase, 9 inches in height, white stoneware, with blue Wood Ash Glaze over Green Dragon Matt Glaze, fired to cone 6 in oxidation.

Small round vase, 6 inches in height, with wood ash sieved on Green Wood Ash Glaze over Green Dragon Matt Glaze, fired to cone 6 in oxidation, by Harry Spring.

Ten Basics of Firing Electric Kilns

From the Pottery Making Illustrated Instructor's File Archives

Firing is the most critical part of the ceramics process because it is the one thing that makes clay durable, hence ceramic. Here are some of the principles of firing and getting the best results with electric kilns.

From Mud to Ceramic

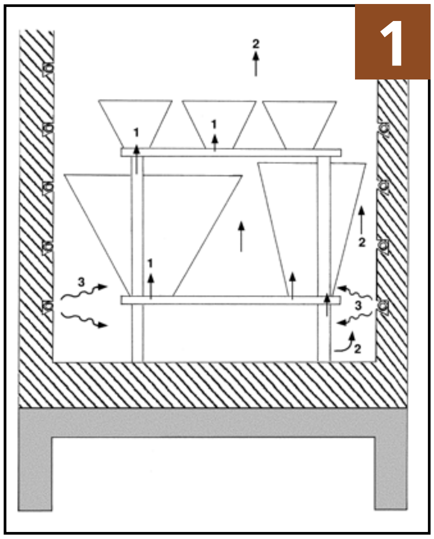
Firing converts ceramic work from weak clay into a strong, durable, crystalline glasslike form. Ceramic work is typically fired twice: it is bisque fired and then glaze fired. The goal of bisque firing is to convert greenware to a durable, semi-vitrified porous stage where it can be safely handled during the glazing and decorating process. It also burns out carbonaceous materials (organic materials in the clay, paper, etc.). As the temperature in a kiln rises, many changes take place in the clay. The Firing Chart (page 135) shows what happens to clay as it heats up.

More Science

Heat in an electric kiln is transferred in three ways (figure 1):

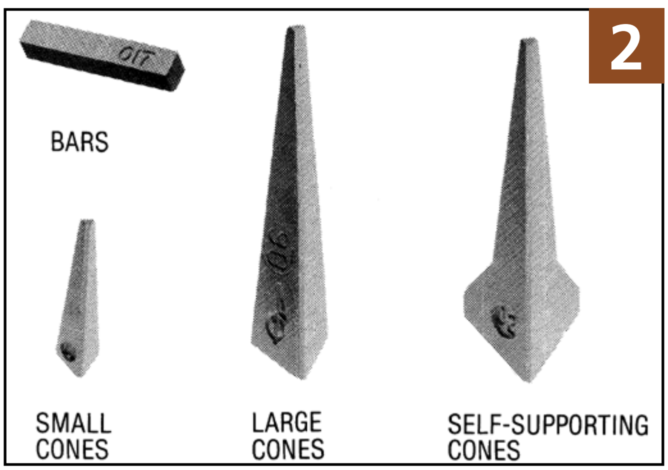
- conduction–heat transferred through physical contact (1)
- convection–heat rising through the air (2)
- radiation–heat emanating from all the kiln elements (3).

Electricity passing through coiled heating elements (made especially for high temperatures) generates radiant heat, which rises and is absorbed by everything in the kiln.



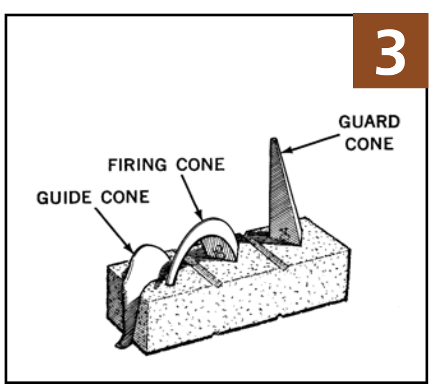
How Hot

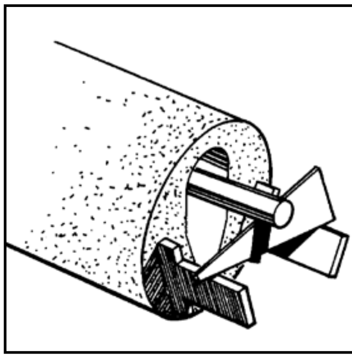
All clays and glazes are formulated to mature at certain temperatures. Firing clay too high can cause it to deform or even melt, too low and it will not be durable. Firing glazes too high can cause run-off on the pot, too low and they will be dry and rough. To fire to the right temperature, pyrometric cones are used. Cones are made from various oxide mixtures and bend at known temperatures (figure 2). In general, the following cones are used in the pottery studio: bisque fire (cone 08–05), low fire (cone 06–04), mid-range (cone 4–7) and high fire (cone 8–10).



Using Cones

Cones are used in every firing. Typically, a three-cone system (either large or self-supporting), consisting of a guide cone that is one cone below the target temperature, the firing cone and a guard cone (figure 3) provides the best information about the firing. Bar cones and small cones are used in a properly adjusted Kiln-Sitter®, an automatic shut-off device (figure 4). While the three large cones are not required for kilns equipped with a KilnSitter or an automatic controller, they do provide a second point of reference for how a kiln is operating.





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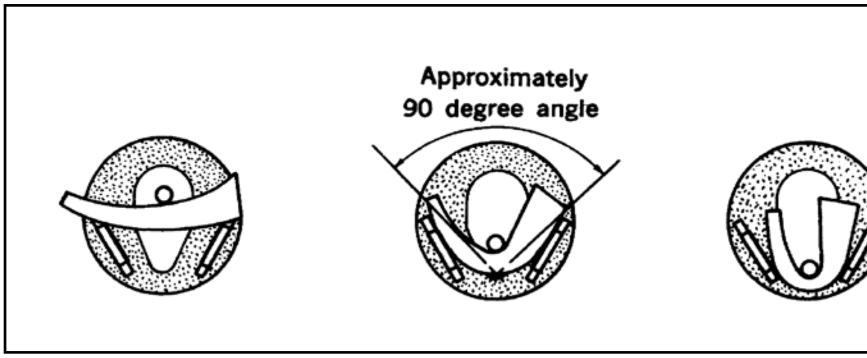

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Get Ready

Before firing any kiln, vacuum it out if necessary—bottom, sides, element channels and lid. Check the elements for breaks, and chisel off any glaze drips on the shelves. Visually check the electrical cords and connections. Make any repairs required (see owners manual or call your local supplier for service).

Kiln Furniture

An assortment of kiln furniture (figure 5) is needed to hold and support ware during a firing. Furniture consists of shelves, posts, stilts and tile setters made from refractory materials. Kiln furniture is designed to withstand the repeated heating and cooling to high temperatures without deforming.

The Bisque Load

Loading a bisque kiln is a fairly simple task, but there are some basic rules. Fire full loads to take advantage of conduction heating and also save electricity. All work should be bone dry . If the work is cool or cold to the touch, it is not bone dry. Handle all work very carefully because it is extremely fragile at this stage. Place the bottom shelf on 1-inch stilts to aid circulation, and keep ware 1 inch away from elements, walls, thermocouple and KilnSitter (figure 6). Unglazed pieces may touch each other. Place a small cone in the KilnSitter and/or a cone pad on the middle shelf. Fire to cone 08–05, depending on the type of clay and amount of porosity you want for glazing.

The Bisque Fire

During the bisque firing a lot of damage can take place. Thicker pieces with moisture or air bubbles create the biggest problem. Clay needs to dry evenly through its entire thickness. If the outside dries faster, it seals off the escape route for the interior moisture. The interior moisture turns to steam and forces its way out (explodes) during the bisque. To avoid this, start off slowly when firing a bisque kiln. Turn on one element to low. If you do not have a downdraft exhaust system, prop the lid open, take the peephole plugs out and keep the temperature below 212°F until all the moisture is gone. Close the lid and check for moisture (hold a mirror or piece of glass up to the top peephole to see

Kiln Controllers

Many electric kilns are now equipped with kiln controllers. Kiln controllers use a signal from a thermocouple (a sensing device that detects temperature) that's located in the kiln. When the controller senses the temperature, it compares this information with a computer program that tells the relays to turn on or off. The relays control current going to the elements. Controllers take the guesswork out of when and how high to turn up the heat on the kiln. Because they are accurate at sensing temperature, they are more efficient than manually-fired kilns. They come with preset programs, or you can even easily input programs to adjust to special firing requirements.

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if it fogs up). Turn on all elements to low for at least an hour then to medium for an hour before turning all elements on to high. The firing is done when the firing cone falls.

The Glaze Fire

Vacuum the kiln, especially if any pieces exploded during the bisque. When firing glazed pieces, make sure there is a thin coating of kiln wash (available from suppliers) on the shelves (figure 7). You do not need a fresh coat for each firing, but any bare spots should be coated. Built-up kiln wash becomes bumpy and should be cleaned off with a chisel. All glazed pieces must be checked to make sure there is no glaze touching the shelf. Coat with wax at least ½inch from the bottom of the piece. Sort work by height and place on shelves with a minimum of ½ inch between pieces and 1 inch from the walls, elements and KilnSitter. Turn the kiln on low for about an hour and then medium for about an hour before turning on to high. The higher the cone you are going to, the longer it will take to fire.

What's That Smell?

Clay and ceramic materials change their chemistry when fired. Carbonaceous materials burn out between 500°F–1450°F. Firing clay materials in electric and gas kilns produces carbon monoxide, formaldehyde, sulfur dioxide gases and more. Some of the byproducts are harmful so vent kilns to the outside. A downdraft vent system works best, but an updraft or crossdraft system is better than nothing. All kilns must be vented to the outdoors.

Safety

Firing is a potentially hazardous activity and all students must obey safety rules to avoid injury. Instructors must read and understand all the safety information that came with the kiln, and assure that the kiln is properly installed and maintained. If a manual is not available, many companies post them online or you can request a replacement copy from the manufacturer. For operating the kiln, students must:

- Turn off kiln prior to loading or unloading. Disconnect the kiln for any servicing or when kiln is not in use.
- Do not touch heating elements with anything since they carry high voltage.
- Do not place any combustibles within 12 inches of any surface of the kiln.
- Do not leave kiln unattended while firing.
- Never look into a hot kiln without properly tinted safety glasses (e.g., welder's glasses). Sunglasses only block ultraviolet light.
- Make sure the ventilation system is working properly.
- Never add extra insulation around a kiln to conserve energy. Extra insulation can cause the wiring and the steel case to overheat.
- Remove all tripping hazards. Keep the power cord out of the way.
- Do not fire with cracked shelves. They can break during firing, which could damage the ware inside the kiln. Store kiln shelves in a dry area.
- If you smell burning plastic, turn the kiln off. Examine the wall outlet and power cord for signs of burning.
- Never wear loose-fitting clothing around a hot kiln.
- Do not open a kiln until it has cooled to room temperature. Pots may break from thermal shock.
- Keep the kiln closed when not in use, and never place anything on the kiln lid, even when the kiln is idle—you may forget.
- Always keep unsupervised children away from the kiln.
- Do not place any objects under or around the kiln stand. Blocking airflow changes the kiln's heating characteristics.
- Remove all flammable materials from the kiln room.