techniques & tips
for electric kilns

inspiration, instruction and
glaze recipes for making
pottery in electric kilns

SKUTT
This special report is brought to you with the support of Skutt Kilns and Pottery Wheels.
Electric kiln firing is one of the most common firing methods because electric pottery kilns are readily available and simple to install. But that doesn’t mean that they yield common results. Electric pottery kilns can be incredible tools in the studio. The authors presented here are creative potters and ceramic artists using electric pottery 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.

Improve your electric firing results and take advantage of the incredible potential offered by electric kiln firing.

**Atmospheric-like Effects for Electric Pottery Kilns**

by Steven Hill

Proving that a neutral or oxidizing atmosphere in an electric pottery kiln can produce exciting results similar to those in atmospheric kilns, Steven Hill focuses on layering glazes and a single-firing schedule. Start with his glaze recipes and firing schedule to get great success in electric kilns.

**Commercial Pottery Glazes Over Texture**

by Deanna Ranlett

To get the most out of commercial pottery glazes in your electric kiln, you need to understand the product descriptions and of course test, test, test! Deanna Ranlett shares the results of testing some commercial glazes over texture.

**Glazing for Success in Electric Kilns**

by Jonathan Kaplan

Layering and combining cone 6 glazes and using a controlled cooling cycle can create some exciting surfaces in an electric firing.

**How to Fire Electric Pottery Kilns**

From the Pottery Making Illustrated Instructor’s File Archives

This introductory/refresher course covers all the bases of firing electric kilns.

**Slow Cooling in Electric Kilns**

by Deanna Ranlett

Slowing down the cooling process in your electric kiln can prevent dunting and create some cool effects.
Wood, oil, gas, or electricity—the fuels used for firing have often inspired potters, but seldom do they determine the success of our finished work. All fuels are capable of producing results that range from mediocre to magnificent. In spite of this, electric kilns, especially when fired to mid-range temperatures, have traditionally been viewed as a less desirable alternative to the fuel-burning kilns of serious potters.

Understandably, many ceramic artists feel a kinship with the fire. There is an undeniable mystique in firing with wood, oil, and gas. Firing with these fuels requires an understanding of the firing process that leads to a relationship with the flame, and potters are also drawn to surfaces that show the “mark of the fire.” It happens naturally in salt, soda, and wood firing, but this kind of surface has never been associated with the predictability of electric firing. Aspiring studio potters looking for visual interaction between the firing process and their work often fire at ceramic centers or community colleges in order to gain access to reduction and/or atmospheric firings.

It can be a daunting experience for the novice to build and fire a fuel-burning kiln. Compared to their “fire-breathing brethren,” electric kilns are safe, affordable, and predictable. Installing and firing an electric kiln is not much more complicated than an electric clothes drier. Because of this, many feel like they make the choice out of necessity, but the typical cone 6 electric-fired pot, with its shiny and rather flat glazes, leaves many potters wanting more. Firing to cone 10 opens up some possibilities, but many electrics are limited to cone 6.

My goal is to dispel the myth that electric firing has to involve compromise. I would also like to encourage potters to take additional responsibility for their surfaces rather than blaming or crediting the kiln gods. Gradually, over the course of my career, I have learned that kiln atmosphere has less impact on the surface of my pottery than I once thought. This is based on my techniques of layering multiple glazes. I want to help potters who are seeking the soft, textured, and varied surfaces traditionally associated with reduction and atmospheric firings to achieve those surfaces regardless of the firing process.
After a little rethinking and adjusting of firing cycles and glazing techniques, you just might be able to free yourself of the alleged limitations of electric firing.

Firing
Fuel-burning kilns tend to be much larger than electric kilns. Because of their size, they usually have a slower heat rise, a soak at the top temperature, and slower cooling cycles. If you want similar results from an electric kiln, especially when firing to cone 6, one of the most important things you can do is emulate the heating and the cooling cycles of larger kilns. This means slowing the temperature gain to about 100°F (38°F) an hour during the last several hours of the firing, soaking the kiln at the top temperature, and then down-firing to slow the cooling cycle. Electric kilns are built with thinner insulation and legs (to allow for air circulation), and they cool very quickly, especially at higher temperatures. If you are seeking buttery, matte surfaces but have trouble achieving them in the electric kiln, it is most likely due to fast cooling. Matte surfaces are usually caused by microcrystal growth during cooling, and, if the cooling cycle is too steep, there isn’t enough time for crystals to develop. In extreme cases, I’ve even seen matte glazes go glossy and transparent.

I came to electric firing with a basic understanding of the significance of the cooling cycle but had my eyes further opened after reading The Many Faces of Iron by Dr. Carol Marians in Glazes and Glazing: Finishing Techniques. Originally published in the June 2007 issue of CM, the article describes a controlled experiment in which one application method, one clay body, one forming process, one firing cycle, and seven different cooling cycles were applied to one cone 6 iron saturate glaze. Amazingly, the results looked like seven different glazes. This started me on what will likely become a lifelong experiment with cooling cycles. Currently I am cooling the kiln naturally from the top temperature down to 1700°F (927°C), down-firing for five hours between 1700°F and 1500°F (816°C), and then cooling naturally. With this cycle, I am achieving some of the best microcrystalline formations I have ever had!

I fired cone 10 gas reduction for 38 years, but, when I began electric firing, I knew it was time to drop my firing temperature in order to preserve elements and electricity. My first experiments were at cone 8, but, to make the final transition to cone 6, I needed to reformulate glazes. With the help of my science/art-major assistant, Mike Stumbras, and Digitalfire’s glaze calculation program Insight, I was able to make the transition rather smooth-

Platter, 16 in. (41 cm) in diameter, thrown and altered porcelain, with ribbed and trailed slip, multiple sprayed glazes, single-fired to cone 6 in an electric kiln, 2011.
Cone 6 Single Firing Schedule

This firing schedule is based on computerized electric kilns. Remember, temperatures are controlled by thermocouples, which are not very accurate devices. Your kiln could be calibrated differently than mine, so you should always use guide cones.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Ramp</th>
<th>End Point</th>
<th>Hold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200°F / hour</td>
<td>220°F</td>
<td>1–3 hours, depending on the wetness and/or thickness of the work.</td>
</tr>
<tr>
<td>2</td>
<td>100°F/ hour</td>
<td>500°F</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>400-500°F/ hour</td>
<td>2100°F</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>100°F/ hour</td>
<td>2160–2190°F</td>
<td>60 Minutes—this temperature is about cone 5, with an hour soak cone 6 should fall. Not all kilns are calibrated the same, some adjustment may be necessary.</td>
</tr>
<tr>
<td>5</td>
<td>9999°F/ hour</td>
<td>1700°F</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>50°F/ hour</td>
<td>1600°F</td>
<td>45–60 Minutes</td>
</tr>
<tr>
<td>7</td>
<td>50°F/ hour</td>
<td>1500°F</td>
<td>No hold, Kiln OFF!</td>
</tr>
</tbody>
</table>

Nothing is static with my firing schedules, however, so it will most likely change in the future. One thing is certain: there is no sense in extending the firing beyond what is necessary for desired results, as this is wasteful of electricity.

My goal is to dispel the myth that electric firing has to involve compromise. I would also like to encourage potters to take additional responsibility for their surfaces rather than blaming or crediting the kiln gods.”

Glazing

In electric firing—and especially at cone 6—it is natural to achieve flat, solid colors that look more paint-like than glazes in reduction firing. If you are seeking a softer effect with more variation and atmospheric qualities, it is up to you to achieve it through glaze application. Remember, the atmosphere is static in an electric kiln, and it’s not going to happen naturally!

Throughout my career, there have been occasional “Ah-ha!” moments, backed up with lots of hard work. The latest revelation came through a conversation with Pete Pinnell, in which he helped me understand how I made the transition from gas reduction to electric oxidation as easily as I did. According to Pete, “In reduction firing, glazes can stratify into layers during the course of the firing. Longer firings and slower cooling cycles, along with the effects of reduction, can result in the creation of complex structures that can result in a variety of beautiful visual effects. Even seemingly opaque glazes can have enough translucency for one layer to subtly affect the next, creating variation and softness in surface color. In oxidation, shorter firing cycles, faster cooling, and an oxidizing atmosphere can result in less layering, simpler structures and less interesting visual qualities.” It just so happens I have been spraying multiple, undulating layers of contrasting glaze on my pieces for most of my career in an effort to achieve a more atmospheric look. In effect, my sprayed layers are accomplishing what happens naturally in reduction firing, and these layers give my surfaces the softness and variation commonly associated with reduction firing.
I am constantly searching for new glazes that will stir my soul and inspire previously inaccessible colors or textures. I both formulate and collect glazes from other sources, but I am constantly experimenting with new combinations. The base glaze that underlies many of the surfaces and encourages crystal formation on my pots is Strontium Crystal Magic, which began as a Tom Coleman glaze, Yellow Crystal Matte. Through an extended series of experiments and the shift from barium to strontium, it ended up far enough afield to warrant renaming. It is rather dull by itself, but it brings glazes layered over it to life.

SCM—Warm loves iron-saturated glazes sprayed over it for rich earth tones. SCM-Cool can develop icy colors with cobalt or copper glazes sprayed over it. Shiny transparent glazes can break from matt to glossy depending on the thickness used. I have never sprayed a workable cone 6 glaze over SCM that didn't show some potential. If you have any interesting cone 6 glazes, I would love to add them to my ongoing glaze experiment.

A totally separate issue in the oxidation vs. reduction debate is color development. Some coloring oxides change color when fired in reduction. The most dramatic of these is copper, which changes from green to red. So, I'm not trying to say that my oxidation-fired pots look just like they would in reduction, but rather that they have all of the subtleness and variation that they once had when fired in reduction and that many of them show no appreciable difference.

Certainly, not all glazes will create inspired surfaces when layered. In my never-ending quest to find new and magical combinations, there are enormous benefits from experimenting with many different types of glazes. Layering similar glazes will create subtle variations, while using highly contrasting glazes can lead to more drama. If you alternate matte and glossy glazes in layers, it will encourage surfaces to break. If you layer light and dark colors, you will get variation in both color and value.

Geoffrey Wheeler uses stains to color his glazes, and he will often color both matte and transparent glazes similarly. When spraying these two glazes, he blends the matte glaze gradually into the transparent glaze, creating a surface that, while uniform in color, gradually breaks from matte to glossy.

Most of my pots have four to eight glazes applied in overlapping layers, and my biggest challenge is making everything look cohesive. Some glazes are sprayed with techniques that isolate one from the other others, like the black or white glazes I apply on the rim of a bowl or the rim, handle, and foot of a pitcher, but most are layered and

recipes

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blended. My intention is for the whole pot to look as if it is one rich and varied surface, much like agate, marble, or layers of metamorphic rock. I want my glazes to ebb and flow (but not run too much!) with color and surface texture gently emphasizing changes in the form. I work with microcrystalline glazes, which can resemble a snowstorm or falling leaves, and use ash-like glazes to encourage streaking, leaving vivid traces of interaction as they melt. Most of my glaze combinations are rather unstable to work with, but, at their best, they have an amazing ability to allure and captivate. One thing is certain: They are never boringly predictable—just as unstable people are often more captivating, enticing, and provocative than those we regard as “pillars of the community.”

If you think about the flame, ash, salt, or soda responsible for the soft surface variations we characterize as “atmospheric effects,” the common denominator is that they travel through the kiln via the kiln’s draft. When you spray glazes, the spray has the potential to wrap around the piece and move past it in much the same way as the draft moves past a pot in a fuel-burning kiln. Spraying layers of overlapping glazes gives you the ability to create surfaces that naturally flow across a piece, softly highlighting its form. As sublime as this can be at its best, insensitive use of a spray gun can lead to surfaces characterized by obvious spray patterns and blotchy color. With experience, however, spraying glazes has the potential to integrate seamlessly with the form.

Think about how clumsy and uncoordinated your hands felt when you first attempted to throw on the potters’ wheel, and compare your experience to how naturally and intuitively a seasoned potter’s hands move across the form, applying pressure just where it is needed. The results achieved as a beginning sprayer are not too dissimilar, but, fortunately, the learning curve is much quicker when learning to spray than it is for throwing!

Spraying has the potential to be every bit as painterly as decorating with brush in hand. As with any painting, you will benefit from both a clear vision of what you are trying to create and the flexibility to let the process lead you in directions you never imagined.

The journey into spraying as my main method of glazing began more than 35 years ago. For most of that time, my goal was simply to create atmospheric surfaces on pottery fired in a gas reduction kiln. When I made the transition to electric firing in December 2008, I was lucky—I had already laid the groundwork for success, or, as Pinnell says, “Luck favors the prepared mind.”

**Plate, 11 in. (28 cm) in diameter, thrown and altered porcelain, ribbed slip design, multiple sprayed glazes, single-fired to cone 6 in an electric kiln, 2011.**

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**the author** Steven Hill has been a studio potter for 40 years. He is a member of 323 Clay in Independence, Missouri, where he makes pots and teaches.
Commercial Glazes Over Texture

by Deanna Ranlett

Part of navigating the use of commercial glazes is understanding the phraseology on the jar. Most glaze manufacturers use terms such as opaque, semi-translucent, translucent, transparent, etc., on their labels. But what do those words really mean? How would each affect the surface if you like to sgraffito, add thick slip, use sprigs, carve, or stamp? To answer this question, I designed a test tile with a little of each of these techniques to test cone 04 and cone 6 commercial glazes and to illustrate some important factors to consider when using these glazes.

The test tiles included: sgraffito using A m a c o ’ s LUG-1 Black Underglaze; dots of white slip made with Little Loafers and 5% Zircopax; an incised diagonal pattern; gemstone-shaped sprigs from plaster molds; a row of stamps; and finally a water-etching. It’s important to make a test bar of your desired texture techniques to use when trying out new glazes so you don’t expect one thing from reading the label or looking at a small tile and get a result you aren’t happy with.

I followed the manufacturer’s directions and brushed three coats of glaze on each tile with a soft fan brush, then glaze fired the tiles to cone 04 or cone 6.

Opaque

Opaque means not letting light through: not transparent.

- Tile #1 Mayco Olive Green FN-021, fired to cone 04: The glaze creates a thick layer of color, almost as if the tile has been coated in paint or dipped into colored rubber. The glaze flows into the incised lines and stamps, and there are only breaks in the glaze where the texture is deep. Even the black underglaze is obscured. This glaze would be ideal if you needed very solid coverage.

- Tile #2 Amaco Amethyst HF-171, fired to cone 6: The glaze is again creating a solid, almost rubberized or enameled effect. The glaze is smooth, even, and flows over the texture, into the recesses, and covers the black underglaze with almost no effect or interaction. This would again be a good glaze for solid coverage.

Semi-Transparent

Semi-transparent means partially or imperfectly transparent.

- Tile #4 Amaco Robin’s Egg TP-26, fired to cone 04: The glaze is capable of showing a break over deeper stamped and water-etched textures, shows a slight break on the gemstone sprigs, and gives highlights on the slip-trailed dots. However, it’s very cloudy over the black underglaze—not showing much of the black, so it wouldn’t be a good choice for sgraffito work.

- Tile #5 Mayco Gray Opal SW-255, fired to cone 6: The glaze creates pools of floaty, semi-translucent crystals that are bluish in hue. The background of the glaze remains gray but where the glaze is thicker it creates these little pools of another color. This glaze highlights the sgraffito work, water-etched, and sprigged areas very nicely.

- Tile #6 Mayco Green Opal SW-253, fired to cone 6: This glaze creates pools of frothy spring green and, while the glaze fills in some of the texture and incised lines, it acts to highlight breaks over texture and slip trailing and also shows the black underglaze very well in the sgraffitoed areas.

- Tile #7 Spectrum Grass Green 1104, fired to cone 6: This glaze is a classic semi-translucent or semi transparent. It doesn’t have a frothy texture but instead is a bit opaque where thick and translucent where thin as it melts and runs over texture. You can see a bit of clay peeking through the otherwise green surface. It also shows the Amaco Black LUG-1 Underglaze sgraffitoed surface very well.

Translucent/Transparent

Translucent means clear or allowing light to pass through.
This type of glaze is perfect for highlighting fine details.

- **Tile #8** Mayco Sky Diamonds CG-975, fired to cone 04: The glaze is showing off each texture to its full advantage, you can see the black underglaze very well and you can also see every facet of the gemstone sprig. It’s worth noting that the physical larger crystal granules you see when applying this glaze pop and pool during firing and you can lose details in those areas. The crystals are the blue and white dots scattered across the fired surface of the tile. You can control this effect to some extent by placing the crystals where you want them when you’re brushing on the glaze.

- **Tile #9** Amaco Lavender C-56, fired to cone 6: You can see this glaze was designed to behave like a true celadon. It highlights each texture, shows the sgraffitoed lines, and really makes the stamps, slip-trailed dots, and water-etched features pop. This glaze is part of Amaco’s new Celadon line, which is formulated to be transparent.

- **Tile #10** Mayco Turquoise SW-201, fired to cone 6: This glaze highlights the textures on the tile, isn’t quite as transparent as the Amaco celadon, but still a lovely glaze to use over a variety of textures. The black underglaze is particularly pretty with the turquoise over it.

Deanna Ranlett owns Atlanta Clay in Atlanta, Georgia (www.atlantaclay.com) and MudFire in Decatur, Georgia (www.mudfire.com).

**Tiles**

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2.  
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Glazes for Success in Electric Kilns

by Jonathan Kaplan

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.

“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.”

Left: Disk Vase, 18 in. (46 cm) 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 in. (38 cm) in height, with Edgy Green glaze. This glaze contains barium, which helps in the formation of small suspended crystals giving it a satiny matte finish.
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. Using kiln wash or stilt 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.

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.

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 Kiln-Sitter or an automatic controller, they do provide a second point of reference for how a kiln is operating.
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.
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 ½ inch 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 by-products 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.

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**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.
own firing, or slow cooling, refers to controlling the rate at which your kiln cools. I’ve programmed my kiln to a slowly cooling rate for a variety of purposes, ranging from slow cooling large work to reduce dunting to cooling slowly and holding at certain temperatures to form glaze crystals. Slower cooling reduces stress on ceramic wares and is well worth the extra time. For glazes containing zinc, rutile, calcium, magnesium, lithium, and iron (to name just a few), slowing the cooling rate can result in some spectacular effects, ranging from feathering to small crystals and in some cases a fully-developed satin-matte surface. The combination of a short soak at peak temperature and then down firing can also eliminate pin holing in some glazes (figure 1).

Many new computer controlled kilns come with built-in preheat or cool-down programs, but I have an older model computer-controlled kiln so I program my own firings. **Tip:** If you plan to use a pre-program set-up, test the program in a typical firing using self-supporting Orton cones to calibrate the kiln. The type of kiln, type of ware being fired, and the size and density of the average ware stack inside the kiln can impact final temperature determinations, but this initial calibration firing gives you a baseline for the length of the firing to reach a specific temperature.

Over the years, I’ve determined that the pre-programmed cone 6 firings tend to overfire my work. I tend to pack my kiln very full and the result of the pre-programmed firing schedule finishes closer to cone 7 than to cone 6. As a result, I’ve researched additional down-firing schedules and came across Ron Roy and John Hesselberth’s *Mastering Cone 6 Glazes* book. In the appendix, I found a perfect starting point for a cone 6 down-firing. To this initial schedule, I’ve made adjustments to suit the way the kiln is loaded, and to take into account what the self supporting cones told us about the firing speed, and the end temperature. I’ve also learned that generally, the slower the climb to temperature, the lower the end temperature, so programming a hold at your desired peak temperature also impacts what the end shut-off temperature should be because heat work continues to occur during those slower periods. A hold at the end of a firing allows a slight soaking effect which allows all work to reach temperature if there’s any unevenness inside the kiln from top to bottom. It also allows glazes to move together and flatten a bit, which is great if you’re creating a reduction-fired effect by layering multiple glazes. Refer to your kiln manual or manufacturer’s website for proper programming instructions.

If you’re down firing for crystalline growth, you want to keep the glaze fluid enough so that crystals can form but not so fluid that it starts to run. In my experience, it’s best to hold the glaze firing for fifteen minutes to about 60° lower than the cut off temperature for a pre-programmed firing. To begin controlled cooling, allow the kiln to cool as fast as it can for the first 300° so the controlled portion of the firing is taking place about 300° lower than the cut-off temperature. I have experimented with different cooling rates ranging from 125° per hour to 175° per hour depending on the type of glazed surface I desire. To prevent dunting (cooling cracks) in a sculpture firing program, the cooling period isn’t done for development of

Karen's Starshine. Left: Fired on a medium speed cone 6 program, results are translucent, glossy, pinholed. Right: Fired to the cone 6 program on page 14, results are opaque, glossy, smooth.

Dixie Teal. Left: Fired on a medium speed cone 6 program, resulting in a glossier, darker color. Right: Fired to the cone 6 program on page 14, resulting in a lighter, speckled glaze.

Frost. Left: Fired on a medium speed cone 6 program, resulting in a glossier, darker color. Right: Fired to the cone 6 program on page 14, resulting in a frostier, satin surface.

John's Tenmoku. Left: Fired on a medium speed cone 6 program, resulting in a glossier, darker in color. Right: Fired to the cone 6 program on page 14, resulting in gold crystals formed when cooling.
glazes but to minimize fast heat loss around larger work. I recommend a cooling rate of about 200° per hour through quartz inversion (1063°F).

Crystal growth in some glazes can vary depending on the rate of down firing—a fast cool results in a glossy surface, while a slow cool goes matte (figure 2). The crystals creating the satin surface are happening between 1900°F and 1450°F. Some glazes can form small crystals during the soaking period but for the most part, the controlled cooling is allowing the crystalline structure to form. **Caution:** Make sure that your glazes aren’t becoming less stable or less food-safe due to changes in surface texture from crystals forming in the glazes. Perform leach tests on all results.

**Controlled Cooling in a Manual Kiln**

While controlled cooling is more difficult in a manual kiln, it’s not impossible. You can re-engage your kiln sitter, which forces your kiln to remain on despite the cone dropping. This is where things can get a little tricky, so you would want to make sure you set your safety timer as a back-up in case you get interrupted and don’t remember to turn off the kiln.

Let the kiln sitter drop and allow the kiln to remain off for 15–20 minutes—the temperature drops rapidly when the kiln first shuts off. After this, use a combination of medium and low switches to create gentle heating as the kiln cools—try 1–2 hours on medium, then 1–2 hours on low so the kiln cools by about 125–175° per hour. This allows extra time for your glazes to develop a crystal structure or for large sculpture to cool slowly. Keep a log of all your changes and results so you can make adjustments to the timing you used to turn switches to medium or low on the down firing.

**Down-Firing Kiln Schedules (right)**

Because the bisque firing has already changed the clay into ceramic material, temperatures can increase faster through the middle of the glaze firing.

**Cone 04 Bisque Firing**

*This program controls cooling for large sculptural ware and prevents cooling cracks.*

- 50° per hour to 150°F—hold 2–6 hours This depends on the size of your work and its dryness
- 150° per hour to 200°F—hold 15 minutes
- 250° per hour to 1000°F—no hold
- 180° per hour to 1150°F—hold 15 minutes
- 300° per hour to 1800°F—no hold
- 108° per hour at 1900°F—hold 5 minutes

On the way down:
- 150° per hour to 1500°F—no hold
- Cool naturally from 1500°F. For large-scale work, cool through quartz inversion (1063°F) at a rate of about 200° per hour, then allow the kiln to cool naturally from 600°F down to room temperature.

**Cone 6 Glaze Firing**

*This program controls cooling for special glaze effects.*

- 100° per hour to 220°F—no hold
- 350° per hour to 2000°F—no hold
- 150° per hour to 2185°F—hold 15 minutes (I use 2175°F to a half-bent cone 6 self-supporting cone)

On the way down:
- 500° per hour to 1900°F no hold (I program my kiln for 9999°F to 1900°F so that I don’t get an error message if the kiln can’t cool at that rate)
- 125–175° per hour to 1450°F—use your glaze results to tell you if this rate should be slower or faster in subsequent firings.
- Allow the kiln to cool naturally from 1450°F down to room temperature.

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Deanna Ranlett owns Atlanta Clay ([www.atlantaclay.com](http://www.atlantaclay.com)) and MudFire Clayworks and Gallery ([www.mudfire.com](http://www.mudfire.com)). She has been a working ceramic artist for 14 years.
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